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A SCIENTIFIC SURVEY OF

DUNDEE AND DISTRICT

PREPARED FOR
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BY VARIOUS AUTHORS

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The Supplement consists of the first five chapters of 'A Scientific Survey of Dundee and District,' prepared for the Meeting in accordance with the practice of recent years. These surveys, since their initiation in 1932, have been issued to members attending the Meetings, and have subsequently been included in the Annual Reports. The intention in future is to include the survey for the forthcoming meeting in the July issue of 'The Advancement of Science' preceding such meeting; whether that scheme will be possible next year, however, cannot be forecast. Meanwhile, it is intended to include further instalments of the Dundee Survey in following issues.

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A SCIENTIFIC SURVEY OF DUNDEE AND DISTRICT

I.

DUNDEE IN ITS REGIONAL SETTING

BY

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The geographical setting of a town is often easy to describe in print but difficult to illustrate in photograph. With Dundee it is rather the reverse, for whilst Dundee lies in a region of contrasts and complexities, topographical, economic, and ethnological, its geographical setting can be seen with somewhat startling clarity at the end of a climb up the Law, the great hill 572 feet high, which dominates the site of the town. Such hills are characteristic of certain Scottish towns, Stirling, Edinburgh, Perth with its Kinnoul Hill commanding the Tay valley, are a few examples. To climb or drive up the Law is the best introduction to the geography of the central parts of eastern Scotland. Immediately below lie the chimneys and roofs of Dundee. There seems to be no arrangement, none of the concentric rings normal to industrial-commercial towns of this magnitude, but even this human mishandling cannot disguise the beauty of the site. Travellers, from Queen Victoria to H. V. Morton, have unanimously agreed that there is nothing very " Bonnie " about Dundee except its situation, and the way in which the site has been occupied is the strongest possible argument for town planning in the future. To look away from Dundee itself in any direction is to pass from confusion to grandeur. Immediately to the south is the Firth of Tay with its vital but, unfortunately, single-purpose bridge, and beyond that the Fife hills with the sands of St. Andrews away to the south-east. Westward the Tay narrows as it approaches the hills of Perthshire, which sweep round to the north into the Grampians with their profusion of Gaelic-titled peaks. In the foreground to the north are the Sidlaws, with their highest point, Craigowl, almost due north of the Law and six miles distant. The intervening lowland, of somewhat indefinite character, suggests trees and arable fields and farmhouses. " This," says one of the most popular travel authors, " is the vision that Dundee men carry with them to the ends of the earth. No wonder that they always go back there some day."

The difficulties of delimiting geographical regions need no emphasis, but regional studies of the British Isles show some unanimity in attempting to handle the Midland Valley of Scotland as a main region divisible into several sub-regions. The unity of the Midland Valley is more evident in historical than in physical geography. It has always been the nucleus, economic and

political, of the Scottish nation, and as Prof. Ogilvie has pointed out, the continuous independence of Scotland until the 17th century may be explained, in part at any rate, by the relative immunity of the Midland Valley from border warfare and attacks from England. This Midland Valley is bounded by two lines of structural weakness, which, running south-west from the neighbourhood of Stonehaven and Dunbar, display the usual " Caledonian " trend. The rocks are mainly sedimentary, for the valley was a basin of deposition of the Old Red Sandstone and later occupied by a shallow arm of the Carboniferous Sea. These sediments are greatly confused, and in close association with them are found intrusions of igneous rock which have shown greater resistance to denudation than the sediments and consequently determine the more prominent surface features of the region. Thus the topography of the Dundee district is dominated by the Sidlaws and the Ochils, both composed of igneous rocks.

The geographical area with which we are especially concerned may thus be regarded as the north-east part of the Midland Valley, and whilst its exact bounds must remain ill-determined, a sub-division may be suggested as a basis for more detailed study :—

(1) The northern corridor of Strathmore.
(2) The Sidlaws.
(3) The coastlands of Angus and the Carse of Gowrie.
(4) The northern parts of the Fife Peninsula.

(1) Strathmore.

Strathmore is a synclinal trough, greatly altered by glacial action, and covered with thick deposits of stiff boulder-clay, glacial and river gravels, and recent alluvium. Entry at the northern end is via a strategic defile controlled by Stonehaven, but once inside the strath there is complete freedom of movement, for much of the bottom is below 200 feet, and remarkable uniformity of structure and scenery. Between this low trough and the Highland scarp is a relatively narrow shelf ranging about 400 feet high, the remnant of a higher peneplain, but cut at intervals by cross valleys leading to the Highland glens. Its front edge is marked by settlements, such as Alyth (1,662) and Kirriemuir (3,326), which command the Highland roads. These settlements originated as centres of trade, as points for the exchange of the products of regions with different physical qualities, but with the decline of the Highland trade, they turned their energies to industry, especially textile manufacturing. With the concentration of industry in places better situated for fuel and sea-borne traffic they have sunk into relative insignificance, except where revival has come through rail or road tourist traffic. As Mr P. R. Crowe has observed, they are excellent examples of the theory that a situation favourable for modern tourist traffic is often no more than a new interpretation of the old trading advantages.

The drainage of Strathmore is to several outlets, in the north-east the Bervie, then moving south-west the North and South Esk, the Lunan, Dean Water, the Isla, and finally the Tay. The first four drain eastwards directly to the sea ; the others south-westward to the region of Scone, where the Tay, which they have now all become, begins its great hairpin bend back to the east. The watershed, lying in the Forfar-Kirriemuir locality, bisects one

of the two groups of lochs which occupy hollows in the glacial drift. Of this eastern group Forfar Loch, about 105 acres, is the largest. Like most of the others it is shallow, though it was both deeper and more extensive before the cutting of an artificial drain to Dean Water. The western group, more numerous and extensive, lies to the south of the Coupar Angus-Blairgowrie-Dunkeld road. Many others have disappeared, either through natural accretion or through drainage for the exploitation of the shell marl which was formerly much used as a fertiliser.

Partly through its soil and climate, partly through its intermediate position between two relatively infertile areas, Strathmore is an important agricultural region, which for centuries exported its surplus produce through Dundee. Naturally, therefore, the towns along the centre of the trough, Coupar Angus (1,893), Forfar (9,659), and Brechin (6,840), developed industries for working up local raw materials and catering for the agricultural population. Coupar Angus especially retains its agricultural character. Forfar and Brechin have developed a wider outlook, due first to their royal and ecclesiastical links, and subsequently to their part in a wider field of economic activity.

For some 25 miles the strath is bounded on its southern edge by the Sidlaws, but this face of the hills, the dip-slope of the lavas, is smooth and gentle compared with the sharp, craggy escarpment which overlooks the Firth of Tay and Dundee. The main centres of population in this part lie at the foot of the hills, generally where transverse valleys encounter one of the longitudinal routes along the strath. Newtyle and Glamis are good examples of this type of settlement. The growth of the former has been closely connected with the railway link with Dundee which follows one of the most important transverse valleys. The early date of this line, 1826, may be taken as indicative of the volume of trade between agricultural Strathmore and the consuming and exporting centres to the south.

Strathmore may thus be described as a lowland trough with rich and sometimes specialised agriculture, with settlements ranging up to the market or small industrial town class in well-defined arrangement, a region which suffered in the past from inadequate drainage, but which, throughout history, has been of continuous strategic and economic importance as a route from the " waist " of Scotland to Aberdeen and beyond.

(2) The Sidlaws.

The Sidlaws mark the eastern extremity of the volcanic hills of the Midland Valley. The configuration of the hills themselves and the neighbouring eminences is determined by the distribution and thickness of the lava-flows. In the east, where these thin out and are separated by lines of sandstones, the Sidlaws form ridges with intervening low ground ; in the higher central Sidlaws sheets of intrusive dolerite have broken through the sandstone, giving the irregular terraced appearance to some of the hills such as Auchterhouse and Balluderon, which reach a height of nearly 1,500 feet ; to the south excessive denudation has completely exposed the roots of the old plugs —at Dundee Law, Balgay Hill, Tealing, and so on. Where the volcanic rock is exposed it weathers into irregular peaks, but generally the hills are long and smooth-backed owing to ice action, and partly clay-covered. Much of

the north-western face has a poor peaty or stony soil, and is mainly a forested or heather district. The southern terraces, on the other hand, have a lighter, dryer loam, and cultivation is found at a height of over 1,000 feet. As a rough generalisation it may be said that the limits of the various vegetation belts are 200 feet higher on the southern than on the northern slopes.

Settlement in the Sidlaw range has been determined by altitude, by lines of communication, and by the nature of the soil. There are still, for example, extensive mosses and peat bogs, though some have been reclaimed. The influence of lines of communication is perhaps most marked in the eastern Sidlaws, where two distinct lines of settlement coincide with two main routes. In this part life depends mainly on mixed farming and quarrying, further west grazing becomes increasingly important. The volcanic hill rampart, of which the Sidlaws form the eastern end, is pierced by a series of gaps, guarded by Dumbarton, Stirling, Perth, and Montrose. Montrose belongs rather to the coastal part of our area, but its position on the lowland strip between the Sidlaws and the coast may be noted here. Perth (34,807), the second most important city in this part of Scotland, occupies a vital strategic position at the lowest road-bridge point on the Tay, between the Ochils and the Sidlaws, and in close and easy contact with Strathmore. For centuries it rivalled Dundee both in land and sea commerce, but lagged behind as Dundee turned more and more to sea trading and ships increased in size. It has, however, developed a very considerable industrial life, and remains a gateway to the Highlands, both for goods and people.

(3) The Coastlands of Angus and the Carse of Gowrie.

The first of these two sub-regions, which can conveniently be treated together, lies east of Dundee and south of the Sidlaws. The landward part has many features in common with Strathmore. Generally speaking, it is a region of gently undulating surface with many wooded knolls, and drained to the south and east by little streams such as the Dighty, some of which have played an important role in the development of the linen bleaching industry. The soils are generally rich, often a mixture of boulder-clay and volcanic debris, which, in this area at any rate, implies great fertility. The glacial formations in this part, such as the long smooth hills a mile long and 500 feet high north of Strathmartine, mark the west to east movement of the Highland ice-sheet which crossed Strathmore and over-rode the Sidlaws.

In many respects the seaward edge is the more interesting part of this sub-region. Part of the coast is exposed to the sea, part to the relatively sheltered Firth of Tay ; in some places the water is fringed by shelving rocks, in others by shifting sands ; so that within a few miles can be found examples of accretion, erosion, and artificial reclamation. The north-east gales fling the waves obliquely against the friable sandstone near Arbroath, the debris drifts along the coast and some settles in inlets between its point of origin and Carnoustie, but the greater part travels in suspension until it encounters the outward currents in the Firth of Tay, where deposition takes place. In this way Buddon Ness, a pointed promontory similar to Dungeness in Kent, has been built up to narrow, but also to protect, the entry to the Tay. Between Buddon and Broughty Ferry both accretion and erosion take place. According to the Royal Commission on Coast Erosion, 56 acres were lost and 46 gained

between 1850 and 1911. The erection of groynes at several points since that time has no doubt retarded the rate of movement. Still further west lie extensive artificial reclamations, extending westward beyond the Tay Bridge. In the 19th century the Dundee Harbour Trust spent three-quarters of a million pounds on the reclamation of 188 acres for docks and warehouses, whilst the Town Council has carried out works of almost equal magnitude for recreation grounds and similar purposes, between them completely obliterating Dundee's original waterfront.

Two other features of this coastline deserve notice here, the sand-dunes and the raised beaches. The former are much in evidence in the Carnoustie-Barry Links locality, and where grass-covered they have been converted into golf links, artillery ranges, or rough pasture. The most conspicuous of the raised beaches is now 21 feet above sea-level. It stretches almost without interruption from Arbroath to Dundee, but varies greatly in width, attaining its maximum in the broad plains of Barry, where it covers 10 square miles. The 50 ft. terrace is much less distinct. The greater part of Broughty Ferry is built on it, but generally denudation has caused it to merge into the lower terrace so that a gentle slope has replaced the step formation. The 100 ft. terrace, actually higher in the west than the east, is conspicuous behind Barry. It consists of stratified sands and gravels on a ledge of denuded boulder clay.

The settlements along this coast display progressive domination by Dundee from east to west. Broughty Ferry, Monifieth (2,984), and Carnoustie (4,806) are all in a measure satellites, though retaining some activities of their own. Arbroath (17,635) and Montrose (10,196) are both populous and remote enough to carry on a much more independent life, each with a definitely industrial flavour and catering respectively for a tourist and military population. Subsequent studies in this volume will deal with many aspects of the life and economy of Dundee (175,585), and it would be presumptuous to attempt a summary here. We may note, however, that Dundee has attained its present stature without the advantages of a populous or wealthy hinterland such as that behind Liverpool or Newcastle. In spite of a long and close relationship both with the neighbouring parts of Angus and with the more remote Highlands, modern Dundee looks outward, towards the industrial centres of England and towards India. The relatively small area covered by the " shopping centre " of the town and the comparative obscurity and tardy development of its higher educational institutions reflect not some shortcoming on the part of the inhabitants, but rather the absence of any definite social and cultural hinterland which would look upon Dundee as its focus.

Even the Carse of Gowrie, immediately west of Dundee, is divided in its loyalties between Dundee and Perth. This sub-region, in Professor Ogilvie's words, is " a district apart." From time immemorial its productivity has bordered on the proverbial: " a plentifull countree," wrote Hardyng in the time of James I., " of corne and catell and all commodities." The Carse has one of the most fertile heavy loams in Scotland, formed mainly from the estuarine clays which cover a foundation of peats of typical Boreal composition. The productivity of this belt is due partly to the soils and partly to its sheltered position at the foot of the steep southward face of the Sidlaws. Its economic activities, like those of the Angus coastlands, are based on mixed

farming, but coloured by the proximity of two cities with an aggregate population of 200,000 and by the fruit preserving industries of Dundee and Montrose.

Along the level surface of the Carse communication is easy, and the situation of Dundee was determined partly by the intersection of transverse routes over the Sidlaws with a main coast route along the terraces north of the Tay. The Carse remains an important rail and a vital road thoroughfare to Dundee, though the latter function would lose much of its importance by the erection of a road bridge lower than that at Perth.

(4) The Northern Parts of the Fife Peninsula.

Whilst Fife clearly falls within the scope of this survey, the relations between it and Dundee are less intimate than mere distance would suggest. Until the late 19th century the Tay below Perth formed an almost complete barrier, crossed only by river ferries, at best a poor substitute for a land route. Indeed, the development of the Fife peninsula down to fairly recent times was dominated by two factors, of which this isolated position was one. The other was the marginal character of the chief religious and trading settlements, and though hard work has converted the interior into good farming country, " a beggar's mantle fringed with gold " is still a not inapt description. Despite the fact that modern Dundee has important economic contacts with the coalfields of south Fife and the linoleum trade of Kirkcaldy, we may justifiably confine the present study to the northern part of the peninsula which lies more directly within the social and commercial orbit of Dundee.

Northern Fife is essentially the Ochil region. These volcanic hills, closely related in structure and substance to the Sidlaws, run from the Firth of Forth to the Tay, thus severing the Fife peninsula from the rest of Scotland. The higher and more conspicuous parts of these hills lie to the south-west of the Dundee area, where they form two distinct ranges with several summits of over 2,000 feet and separated by a longitudinal valley drained by the head-waters of the Devon. Glendevon cuts across this system and at that point the longitudinal valley disappears. Ten miles north-east of Glendevon comes another transverse, dropping to below 500 feet. To the north this drains by the little river Farg, to the south it opens into the lowlands near the watershed between the Howe of Fife and the Loch Leven basin. With Glenfarg ends that part of the Ochils which can properly be called mountainous: the importance of Glenfarg as the first low crossing place east of Strathallen is a key fact in the human geography of the region.

East of Glenfarg the hills sink to below 1,000 feet and come close to the Tay. The settlements north and south, Abernethy (1,154), Newburgh (2,152), Strathmiglo (1,561), and Auchtermuchty (1,747), all occupy sites of a familiar nature, and are linked by roads which cross the hills and converge on Falkland, once a residence of the Scottish kings. Eastward again is another transverse linking the Howe of Fife to Newburgh and the Tay and holding the small Lindores Loch. Thence the hills again divide into parallel ranges with a longitudinal valley, followed both by a road and by the old Newburgh and North Fife Railway. The northern range rises to Norman's Law (936 ft.), then sinks to wooded eminences above Tayport (3,164), and finally ends above the sand-dunes of Tents Muir. The southern range rises to and ceases

in Lucklaw Hill (625 ft.), around the base of which the longitudinal valley drains away to the River Eden.

To the south of these eastern limbs of the Ochils lie Stratheden and the Howe of Fife, as that part of the strath west of Cupar is generally called. These form a relatively low-lying plain, crossed by busy road and railway systems, with Ladybank and Leuchars as the main railway junctions. The soils are mostly heavy loam with scattered patches of gravel, drained by streams which come from the Ochils and the Lomonds to form the Eden. After meandering north-eastward the river passes through a bottle-neck at Cupar (4,595), a market-town now famous for its beet-sugar, where the hills of the East Neuk press northward towards the low spurs of the Ochils. Thence to the sea the valley is narrow, and the muddy, winding estuary finally emerges between the wide raised beach of Tentsmuir, mainly a heather-covered expanse of fixed dunes, and the links of St. Andrews (8,269). Here, where so much of the religious, academic, and sporting tradition of Scotland is embodied, this survey may well conclude.

II.

THE GEOLOGY OF THE DUNDEE DISTRICT

BY

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THE relation of the topography to the geological structure of the district shown on the accompanying map is comparatively simple. The Grampian Hills, formed of metamorphic rocks, lie to the north-west, and are separated from the Highland Border Series and the Lower Old Red Sandstone by the Highland Boundary Faults. The rivers of the Isla and the Earn have cut their valleys out of the softer Lower Old Red Sandstone sediments, resulting in the former case in the capture of the older consequent streams descending from the Grampians. Lower Old Red lavas, occurring in a broad anticlinal fold, give rise to the Ochil Hills which open out to the north-east into the Sidlaw Hills, and the hills of north-west Fife and south-east Angus. The river Tay cuts through the Sidlaws east of Perth, and after being deflected by the southern limb of the anticline for a matter of sixteen miles, breaches it between Tayport and Broughty Ferry. Between these two anticlinal limbs sediments of the Lower Old Red Sandstone outcrop, with patches of Upper Old Red Sandstone faulted down at Balruddery, Clashbenny, and at Dron, where representatives of the Lower Carboniferous are also included.

The Lower Old Red Sandstone was folded and denuded before the Upper Old Red Sandstone was deposited on the upturned edges of the lavas, but the junction is concealed in Fife under Pleistocene Drift. The relatively soft beds of the Upper Old Red Sandstone have given rise to the plain of Kinross and the Howe of Fife. To the south-east, the Upper Old Red Sandstone either passes up into, or is faulted against, Lower Carboniferous sediments into which dolerite sills have been intruded; whilst numerous volcanic vents are scattered throughout the area. The dolerite sills and some of the limestone bands give rise to escarpments, whilst the vents often produce conical hills such as Largo Law.

The Lower Carboniferous sediments dip under the grits and Coal Measures of the Leven tectonic basin, and another Coal Measure area is preserved by faulting in the neighbourhood of Kinglassie. The district presents evidence of severe glaciation as shown in the moulding of the hills and by the deposits of sands, gravels, and Boulder Clay, which spread over the low lands and creep up to the higher ground.

The Carse lands bordering the Tay and the Earn, the valley of the Eden, and much of the low ground flanking the coast-line are covered by deposits belonging to the period of the raised beaches, together with fresh water alluvium, peat, and blown sand.

The Highland Border Series.

This Series can be sub-divided into two groups which are separated by an unconformity. The lower group consists of shales, grits, jaspery phyllites, and spilitic lavas, with basic and ultrabasic intrusions. The upper group or Margie Series is composed of grits, shales, and limestones. The Series is exposed at various places along the line of the Highland Faults, and the lower group has yielded brachiopods, etc., at Stonehaven and Aberfoyle, and is presumably Cambrian in age. Crinoid plates and calcareous algae have been found in the Margie Series at Upper Donans, and this group has been ascribed to the Ordovician.

The Lower Old Red Sandstone.

Including the abundant contemporaneous volcanic rocks, the thickness of the Lower Old Red Sandstone deposits of Angus and Perthshire is probably about 17,000 feet. The sediments consist of sandstones, shales, marls, and conglomerates, the last showing an interesting variation in lithology according to their stratigraphical level. Thus the lowest beds, forming a basement breccia exposed close to the Upper Ericht, are characterised by angular pebbles of quartzite, jasper, and other rocks derived from the Dalradian and Highland Border Series. At a somewhat higher horizon the pebbles in the conglomerate consist mainly of rhyolite and other acid volcanic rocks. These beds are later succeeded by other conglomerates in which basic volcanic pebbles predominate, and in the highest conglomerate belt there is a reversion to rounded pebbles of quartzite, schist, and other rocks similar to those occurring in the basement breccias. In the southern part of Angus conglomerates are not generally so extensively developed as close to the Highland Border, and sandstones, flagstones, and shales predominate. The Carmyllie Group of sandstones and flagstones contains, towards the middle of the Series, the main fossiliferous horizon, from which numerous species of fossil fish, Eurypterids, and primitive plants have been obtained.

The great development of contemporaneous volcanic rocks interbedded with the Lower Old Red Sandstone sediments may conveniently be divided into three groups, with in all probability different centres of eruption. (1) The Highland Border Region where the lavas are mainly of andesitic composition, but in the lower part of the sequence the eruptives are rather more acid than the average rocks of the great lava-piles towards the south and east. (2) The lavas of the Montrose centre reach a thickness of several thousand feet, but thin out towards the north-east and south-west, where the flows become intercalated with sandstones and conglomerates. The rocks consist mainly of enstatite-basalts or andesites, with and without olivine; there are no associated vents, the main centres of eruption probably lying under the North Sea. (3) The main volcanic pile of lavas, tuffs, and agglomerates forming the Ochil and Sidlaw Hills reaches in the neighbourhood of Stirling a maximum thickness of over 6,500 feet without the base of the lavas being revealed. Augite, hypersthene, and enstatite andesites form the common rock-types, with biotite-andesites and dacites in the North Fife Hills, whilst great spreads of volcanic tuff and conglomerate occur to the south of Newburgh. In all the volcanic areas agates, chalcedony, etc., are abundant in the vesicles of the lavas.

Intrusive igneous rocks of probable Lower Old Red Sandstone age are well developed within a circle of nine or ten miles radius of Dundee, where sills, dykes, and plugs, as well as more irregular masses, are represented, and a large part of the city is founded on igneous formations of this character. Petrographically the intrusions show considerable variation, consisting of quartz-hypersthene-dolerites, Balgay Hill, Den of Mains, Rossie Hill-Lundie; augite-porphyrites, Dundee Law, Craigie; ophitic basalts, south of Glamis and at Auchterhouse Hill; tholeiites, Auchterhouse and on the site of the old Dundee prison. Oligoclase-porphyrites occur in the railway cutting at Seabraes, west of Dundee, where the corrugated roof of the intrusion has domed the overlying sandstones. Similar rocks occur in Fife at Lucklaw Hill and at Peashill Point, Wormit, the latter being associated with intrusive breccias. A quartz-diorite intrusion is found at Glenduckie Hill, three miles east of Newburgh.

Conditions of Deposition.

The Lower Old Red Sandstone sediments were formed under semi-arid conditions to the south-east of the Caledonian mountain ranges, the sandstones being partly of fluviatile origin and partly formed in temporary lakes. The conglomerates represent torrential gravels which were swept down from the hills and spread out over the lower ground, whilst the lavas were erupted from volcanoes situated in the foothills or scattered over the plains. Fine sediment was frequently washed into cracks and cavities in the lavas, forming veins and pockets or lenticular intercalations between the flows. Towards the close of Lower Old Red Sandstone times the area was subjected to earth-movements with the formation of the Strathmore syncline and the Ochil-Sidlaw anticline, followed by a long period of denudation.

The Upper Old Red Sandstone.

Deposits of this age underlie the Howe of Fife, whilst outliers in the Carse of Gowrie have been preserved by trough-faulting along the crest of the Ochil-Sidlaw anticline; other exposures are to be seen on the coast at Arbroath, Boddin Point, Montrose, and St. Cyrus. Sandstones, marls, and conglomerates form the bulk of the sediments, but cornstones may be developed locally as at Boddin Point. The most famous section in the Fife Upper Old Red Sandstone is that cut by the Ceres burn in Dura Den, where in former excavations great assemblages of fossil fish remains were found crowded together at one horizon in the yellow sandstone. The species discovered included representatives of Bothriolepis, Phyllolepis, Glyptopomus, Holoptychius, and Phaneropleuron.

The Carboniferous.

A. The Calciferous Sandstone Series.

The Upper Old Red Sandstone sediments, where the junction is not faulted or obscured, pass up conformably into the basal beds of the Calciferous Sandstone Series, but it is difficult to decide where the dividing line should be drawn. Between Fife Ness and Randerstone Castle, and again between Cambo Ness and Kingsbarns Harbour, a series of red and green clays and shales, sandstones, cornstones, chert, and andesitic conglomerates occur.

These probably represent passage beds between the Old Red Sandstone and the Carboniferous, but the base is not visible and their relationship to the overlying Randerstone Beds is obscured by faulting. The sediments of the Calciferous Sandstone Series in East Fife consist of alternations of sandstones, shales with ironstones and cementstones, fireclays, coals, and limestones; the most complete exposure of this Series is to be seen between Anstruther Harbour and Coalfarm, east of St. Monans, where the Hurlet or Coral Limestone outcrops on the foreshore. Here, according to Mr J. W. Kirkby's table, about 4,000 feet of strata are exposed, and include a number of limestones and shales crowded with lamellibranchs, gastropods, entomostraca, etc. At a depth of 2,280 feet below the Coral Limestone occurs the zone of the "Encrinite-bed," which is also exposed repeatedly on the foreshore between Buddo Ness and St. Andrews. The highly fossiliferous Randerstone Beds are bounded by faults, but their probable equivalents in the Anstruther section lie about 1,000 feet below the horizon of the "Encrinite-bed." The Calciferous Sandstone Series thins rapidly to the westwards, and is represented by only a few feet of strata at the Lomond Hills, whilst beds of "Cementstone type" have been preserved by faulting at Dron, near Bridge of Earn. There is a marked absence of evidence of contemporaneous volcanic activity of this age in East Fife as compared with the district between Burntisland and Kirkcaldy.

B. The Carboniferous Limestone Series.

This Series is sub-divided into the Lower Limestone Group, the Limestone Coal Group, and the Upper Limestone Group. The base of the Series is considered to lie about 20 feet above the Hurlet or Coral Limestone of St. Monans, which is quarried for the limekilns at Cults. The Lower Group consists mainly of shales and limestones, with interstratified sandstones, fireclays, and thin coals. Locally the limestones are known as the Hosies, and afford indications of having been deposited in rather clearer water than those of the Calciferous Sandstone Series. The Limestone Coal Group extends from the top of the Top Hosie Limestone to the base of the Index Limestone, and consists of an alternating series of sandstones, shales, fireclays, coals, and ironstones. The principal coal seams are worked in the neighbourhood of Dunfermline, Lochgelly, Kirkcaldy, and Markinch. The Upper Group indicates a return to marine conditions similar to those under which the lowest group was deposited. The strata consist of sandstones and shales, with the Index Limestone at the base, the Calmy Limestone near the middle, and the Castlecary Limestone at the top. Thin seams of coal occur and are workable in the Capeldrae district; whilst the interstratification of ashes and sediments in the neighbourhood of Largo points to contemporaneous volcanic activity.

C. The Millstone Grit and the Coal Measures.

The Millstone Grit, as exposed between Pathhead and Dysart, consists of gritty sandstones and conglomerates with shaley intercalations, and passes up gradually into the Coal Measures of the Leven and Kinglassie coalfields. The Coal Measures can be divided into two groups, the Lower or Coal-bearing Group, consisting of about 1,700 feet of sandstones, shales, ironstones, fireclays, and workable coal seams which appear to have been

formed in situ. Near the top of the group Mr Kirkby discovered a band of marine fossils similar to those which occur in the Carboniferous Limestone Series. Musselbands referable to the lower Similis-Pulchra zone occur near the top of the Lower Group, and the Ovalis zone is represented by a band above the Dysart Main Coal. The Upper or Barren Red Measures are composed of red and white sandstones, shales, fireclays, and a few thin seams of coal.

Conditions of Deposition of Upper Old Red Sandstone and Carboniferous Sediments.

The conditions prevailing in the earlier part of Upper Old Red Sandstone times were somewhat similar to those obtaining in the Lower, but as subsidence and deposition proceeded, shallow continental basins were formed, in which the sediments were partly of fluviatile and partly of lacustrine origin, and were often subjected to periodic desiccation. The passage to the Carboniferous was gradual and was mainly determined by local conditions, but early in Calciferous Sandstone times periodic marine invasions took place over East Fife. The bulk of the sediments appear to have been deposited in lagoons, or shallow coastal flats, which emerged at intervals to give rise to coal measure swamps, or sank beneath the sea. The greatest submergence is recorded by the Hurlet Limestone, when the sea covered most of the Midland Valley and was clear enough for the formation of banks of the coral Lithostrotion. Deltaic conditions probably occurred at the time of the formation of the Billowness Sandstone in Calciferous Sandstone times, and again in the Millstone Grit period. Towards the close of the Carboniferous the swamps in which the Coal Measures were deposited must have largely dried up, for the upper part of the Barren Red Measures appears to have been deposited under semi-arid conditions.

Igneous Rocks of Carboniferous and Permian Age in East Fife.

A. Volcanic Vents.

The large number of volcanic vents which are scattered about the district appear to be confined to the Carboniferous area. They vary in ground plan from circular or elliptical outlines to irregular or dyke-like forms, and are filled with basaltic agglomerate or tuff together with a certain amount of sedimentary fragments, but in some cases the igneous material is wanting. Around the margin of the vents the strata often shows signs of having been bent or faulted down towards the pipe, whilst the larger vents may contain masses of steeply-dipping bedded ash, due to the sliding of material into the orifice during periods of quiescence or after extinction. Plugs and dykes of basalt, often showing columnar structure, frequently penetrate the vent material and the surrounding strata, and may be so completely filled with basaltic and sedimentary fragments as to stimulate agglomerates. The lava varies from an olivine-basalt, with monoclinic pyroxenes and low felspar content, to a monchiquite; analcite and nepheline may be present in the groundmass, whilst xenocrysts of soda microcline, hornblende, biotite, augite, and olivine segregations are sometimes present. The mineral assemblage in some of the vent materials resembles that of the "Blue Ground" of the South African diamond pipes. Certain vents in the neighbourhood of St.

Andrews pierce the local anticlines in such a way as to make it appear that these necks must be of later date, but the age of these folds is uncertain. The vent at Lundin Links, which cuts the Coal Measures, some containing rounded quartz grains, and possibly the necks including quartz-dolerite fragments, appear to belong to the Permian Period.

B. Dolerite Intrusions.

These occur as sills or dykes which can be separated petrologically into two distinctive groups, the quartz-dolerite- -tholeiite suite and the teschenite- -theralite suite.* The main sills of the former group lie roughly west of a line from Leven to Guard Bridge, and the olivine-dolerites, etc., of the latter group lie to the east of this boundary. Dykes of the quartz-dolerite- -tholeiite suite, with the characteristic E-W trend, are common in the Old Red Sandstone area to the west, and a quartz-dolerite dyke cuts vent material two miles east of St. Andrews. On the other hand, fragments of quartz-dolerite are found in certain of the vents, and a volcanic neck pierces a quartz-dolerite sill on the Lomond Hills.

Folding and Faulting.

The coast-section from Fife Ness to Dysart commences low down in the Calciferous Sandstone Series, and gradually ascends through a repetition of anticlines and synclines to the Coal Measures of the Leven basin. The sediments displayed on the foreshore between Fife Ness and St. Andrews belong to the lower part of the Calciferous Sandstone Series, and do not ascend much higher than the zone of the " Encrinite Bed," but in both cases the sequence is repeatedly interrupted by minor folds, faults, and volcanic vents. Certain local folds and faults occurring in the neighbourhood of the vents must be due to the volcanic eruptions, whilst others are considered to be of an igneo-genetic character dependent on the intrusion of the dolerite sheets or sills. The main folding which gave rise to the broad anticlines and synclines must have taken place in late Carboniferous or Permian times, but the age of the local folding has not yet been conclusively determined. Normal, reversed, and transcurrent faulting is represented, and one of the latter, with N.E.-S.W. trend, has shifted the vents in the neighbourhood of Elie. The throw of the faults varies from a few inches to several thousand feet, but it has not so far been found possible to trace the major faults for any great distance with certainty. It is probable that the transcurrent faults of N.E.-S.W. trend are later than the E.-W. faults, and may represent the last phase of movement in the district ; the majority of the faults appear to be Permo-Carboniferous in age.

Pleistocene and Recent.

There is abundant evidence to prove that throughout a large part of the Pleistocene Period the area was subjected to intense glaciation. The general alignment of the glacial striae on the lavas of the Ochils, and the dolerite sills of East Fife, is from west to east, but towards the coast of Angus the direction of movement was north-easterly. Examples of " crag and tail " are numerous,

*For the distribution and petrology of the rock-types see list of references given in British Regional Geology, The Midland Valley of Scotland.

as on Largo Law, where the boulder-clay lies 700 feet up on the seaward slope, but hardly 300 feet above sea-level on the landward side. Erratics are found all over the district and consist of Carboniferous rocks, Old Red lavas and sediments, and gneisses and schists from the Highlands. A tough unstratified boulder-clay covers a large part of the area ; it contains sub-angular striated stones similar in composition to the erratics, but rocks, whose origin is obscure, are sometimes found in the clays. Evidence of an interglacial period is recorded from Kincardineshire, but nothing of this nature has so far been discovered in Fife.

Phenomena connected with various stages in ice-retreat are well developed in the district, such as overflow channels, kames, eskers, and the remains of temporary ice-dammed lakes. The fluvioglacial and glacieluvial deposits at St. Fort are over 200 feet thick, and their base extends to forty or fifty feet below sea-level.

According to evidence obtained by J. B. Simpson, a late readvance of Highland ice took place down the Teith valley and upper Strath Earn to form a " Piedmont " glacier which reached the late-glacial sea in the region of the Firth of Tay. It seems probable that about the time of the " Perth readvance " the sea-level stood approximately 100 feet above that of present mean-tide, and that the shell-bearing arctic clays of Errol, Carse of Gowrie ; Guard Bridge, Seafield, and Elie were formed about this time, together with the sands, gravels, and erosion terrace of the 100 foot Raised Beach. The arctic clays represent the off-shore or estuarine equivalents of the 100 foot beach deposits, and often contain fragments of chalk, flint, and other Cretaceous rocks, whilst at Errol the fine brownish-red clay contains occasional boulders dropped from floating icebergs, and shells of types indicating very cold conditions such as occur off West Greenland at the present time. The 100 foot beach varves at Dunning in Strath Earn are considered by De Geer to have been formed rather more than 13,000 years ago. The coastal 50 foot Raised Beach probably represents a temporary halt in the recovery of the land, which finally emerged until it stood slightly above the present sea-level. To this period can be ascribed the peat deposits, containing remains of birch, alder, willow, hazel, and pine, which occur on the coast and up the estuary of the Tay. After the Submerged Forest Period the sea-level rose and the 25 foot Raised Beach was formed. It is the best developed of all the beaches and forms an almost continuous terrace from Elie to St. Andrews, where it underlies the Links and the sand-dunes of Tents Muir. The Carse clays and the deposits underlying the blown sands of Barry, Carnoustie, and Montrose also belong to this period. In the Carse of Gowrie the mudflats rose to a rather higher level, and estuarine silts were deposited in which Neolithic implements have been found. The final fall of the sea to the present level probably took place some four or five thousand years ago. An investigation of the tide levels recorded over the last hundred years at Dundee harbour indicates that during this period the land has remained stationary.

D. E. I.

In the preparation of the above brief account of the Geology of the Dundee District the following books and papers have been consulted :—

The Geology of Eastern Fife, 1902. Sir A. Geikie.

The Geology of the Country Around Dundee. British Association Handbook, 1912. R. M. Craig and D. Balsillie.

East Fife. Proceedings of the Geologists' Association, Vol. XXXVIII. (1927), pp. 453-469. D. Balsillie.

Scottish Carboniferous Stratigraphy. The Transactions of the Geological Society of Glasgow, Vol. XVIII., Part III. (1928-29). M. Macgregor.

British Regional Geology. The Midland Valley of Scotland, 1936. M. Macgregor and A. G. Macgregor. With list of selected references.

Notes on the Geology of the Elie District. Supplied by G. A. Cumming.

Notes on the Old Red Sandstone and Glacial Deposits of Perthshire and Angus. Supplied by C. F. Davidson.

Era.	System and Subdivision.	Igneous Rocks.
Quaternary	Recent and Pleistocene: Blown Sand. Peat. Freshwater Alluvium. Marine Alluvium. Sand and Gravel. Boulder Clay.	
Tertiary	Period of erosion.	
Mesozoic	Absent, but Cretaceous sediments may have been deposited and subsequently eroded in Tertiary times.	
Upper Palaeozoic	*Permian.* Folding and Faulting in Permo-Carboniferous times.	Volcanic Necks. Quartz-dolerite dykes and sills.
	Carboniferous: Barren Red Coal Measures. Productive Coal Measures. Millstone Grit. Carboniferous Limestone Series. Calciferous Sandstone Series.	Volcanic Necks of uncertain age. Dolerite Sills. Lava and ash near Largo. Lavas, tuffs, and necks, Burntisland-Seafield.
	Old Red Sandstone: Upper Old Red Sandstone. Period of Folding and Erosion. Lower Old Red Sandstone.	Intrusions near Dundee and Leuchars. Lavas of Sidlaws, Ochils, etc.
	Junction with Highland Border Series Faulted.	
	Ordovician-Cambrian. Highland Border Series.	Lavas and Intrusions.
Pre-Cambrian ?	Junction with Highland Schists Faulted.	
	Highland Schists.	

III.

CLIMATE OF THE DUNDEE DISTRICT

BY

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In making a study of the " climate " of Dundee we find that certain factors operate to cause local differences within the City and to separate and relate the City to the District. The most noteworthy of these are :—

(*1*) *Site.*—The city stretches E. to W. along the north bank of the Tay estuary at its narrowest. Here a bridge and a ferry join the city to its " dormitories," Newport and Wormit, on the southern bank. West of the bridge there is virtually an inland sea, tidal, 2-3 miles wide, and surrounded by hills. The western districts of the city have protection against most of the winds except the prevalent one, the S.W., which sweeps down the Tay valley through the gap between the Sidlaws and the Ochils and Fife Hills. The eastern districts and the lower estuary, where are situated the docks, are slightly more sheltered from the S.W. wind, but are somewhat more exposed to the other winds ; to the east, on both sides of the river, the land sinks to sandy stretches facing the open sea.

(*2*) *Aspect.*—The city also lies on the fairly steep slopes of the ridge formed by the Law (572 feet) and Balgay Hill (362 feet). The greater part of the city thus has a southern aspect, but the northern districts are higher (300 feet or over) and face the north.

(*3*) *Distance from the Open Sea.*—The city lies about ten (10m.) miles inland, and backed by hills, has less sunshine and more rain than places actually on the seaboard. Nevertheless, Dundee lies within the sunny East Coast belt extending from Aberdeen to the Forth. The higher ground to the north outside the city boundaries, where are situated the city reservoirs, has a much heavier rainfall.

Detailed instrumental observations for Dundee (Mayfield)—147 feet—are available only since 1923. Readings for sixteen (16) years, up to and including 1938, are submitted. This gives about half the range of readings taken to furnish the " Normals " for the district. The Eastern Necropolis, where the 35 year series of readings were taken (1881-1915), differs little in height from the present station, and lies about 300-400 yards to the east. Apart from difference in the time of observations, some comparison is possible. Sunshine is measured on the roof of the Training College, in the centre of the city. Just outside the western boundary is Balruddery (276 feet), for which another set of " Normals " is available.

TABLE I.

DUNDEE (MAYFIELD), 1923-1938.

	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Mean Max.	43·8° F.	43·7	46·7	50·8	56·0	62·7	67·1	65·9	61·5	54·0	46·7	43·4	53·5
Mean Min.	34·8° F.	33·8	35·8	38·1	42·1	47·2	51·8	51·0	46·9	41·9	36·5	35·1	41·3
Mean T° Range	9·0° F.	9·9	10·9	12·7	13·9	15·5	15·3	14·9	14·6	12·1	10·2	8·3	12·2
Mid T°	38·8° F.	38·8	41·3	44·5	49·1	55·0	59·5	58·5	54·2	48·0	41·6	39·3	47·4
1884-1915	37·1° F.	37·5	39·8	44·1	49·4	55·4	58·4	57·3	53·5	46·7	41·3	37·6	46·5

DUNDEE.

The figures in Table I. would suggest that the period under review was warmer than the pre-war period (1881-1915). This is most marked in the winter months, December-March. The early summer months, April-June, may even be slightly cooler, and late summer, September, appears to be only slightly warmer. November figures are about the same in both periods, but an increase is revealed by the figures for the summer months of July and August—over one degree, 1° F., of a rise.

TABLE II.

LOWEST MIN. TEMP. AND HIGHEST MAX. TEMP. FOR EACH MONTH.

Lowest.			Highest.	
1931	11° F.	Jan.	56° F.	1925 1932 1935
1929	12° F.	Feb.	57° F.	1925 1935
1931	13° F.	Mar.	68° F.	1929
1928	19° F.	Apr.	70° F.	1937
1929	21° F.	May	72° F.	1934 1937
1926 1936	29° F.	June	79° F.	1933 1938

Lowest.			Highest.	
1935 1938	36° F.	July	86° F.	1933
1932	30° F.	Aug.	81° F.	1935
1933	23° F.	Sept.	74° F.	1938
1925 1930	19° F.	Oct.	67° F.	1927
1930	15° F.	Nov.	61° F.	1933
1935	11° F.	Dec.	56° F.	1926 1931

Monthly Range Extremes 50° + or − 5° F.

The " mean " Range conceals an exceedingly wide range of extremes, as will be seen from Table II., which shows the recorded " limits " and the year of occurrence. In most years temperatures fall to 20° F. and under during the period December-March ; and February usually has temperatures falling even below 18° F. On the other hand, during these months Day Temperatures will seldom fail to reach 50° F. The upper limit, 86° F., was touched on one single day, but during most years temperatures of 75° F. and over are recorded in June, rising to 78° F. in July ; during this month 80° F. (and over) is not uncommon. In August the most common upper temperature is about 72° F., although 81° F. was recorded in 1935. In the summer months air temperatures falling below 32° F. are infrequent, although they are on record ; but during June and August in most years temperatures will fall below 35° F. and below 40° F. in July.

Table III.

Ground Frost.

Average Occurrence (1923-1938) of Temps. 30° F. and Below on Grass.

January	....	17	July	....	—
February	....	15-16	August	....	?
March	....	14	September	....	1-2 (16*th**) (earliest)
April	....	8-9	October	....	8
May	....	3-4 (21*st**) (latest)	November	....	14-15
June	....	1 in 5 years.	December	....	16-17

Table III. shows that Night Frost may occur in every month of the year, with the exception of July, although it is rare in June (once in every 5 years) and exceedingly rare in August (two nights in 1932—the only time in the period). To the gardener, the mid-week of May represents the end of the danger period, and planting out of the less hardy plants can be undertaken, e.g. Dahlias. In the higher and more northern districts it will be safer to allow another week to elapse. The earliest frosts may come about the 16th September, but plants seldom shrivel up before end of October; in most years in sheltered places there is little danger until the end of the month. Chrysanthemums are usually safe out of doors during all November, and Dahlias may remain in full bloom, in favourable years, until December.

Winds.

Ground Frost happens most frequently during periods of relative calm, when wind velocities are of the order 2 or under. Usually there are clear skies overhead, and the waters of the estuary, particularly above the bridge, are without a ripple. Calms, however, especially during March-April and September-November, may be accompanied by mist over the water. Frost seldom occurs when the wind is from the East. The East wind is probably the most disagreeable of the winds, bringing cold and miserable weather, with persistent drizzle in the winter, and carrying a " haar " right up the river in spring and in summer. Although it may " feel " cold, it seldom brings temperatures below Freezing Point. The prevalent wind is the South-West, following the line of the valley. It frequently brings rain, and the approach of a downpour in the summer can be seen as a dark screen, stretching the whole width of the valley. The northern parts of the city experience, with little mitigation, the cold wintry blasts from the north.

Wind velocities are mainly of the order 3-4-5, varying, with position throughout the city, east or west, high or low. Wind velocities tend to rise somewhat towards the end of the year, and reach gale force most frequently in October, December, January, February. In November there is a lull.

Table IV.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1923-1938	35	22	9	6	2	7	1	3	18	23	9	33	168—16 yrs.
1930-1938	32	18	5	6	1	4	—	2	11	11	8	20	118— 9 yrs.

Since 1930 the frequency of gales seems to have increased, over 70% of the total falling within the latter half of the sixteen year period. One particular " observation " may be of interest, in that the piers of the first Tay Bridge still remain as evidence of the most destructive gale of 1879.

TABLE V.

RAINFALL IN INCHES.

DUNDEE (MAYFIELD).

	1923-1938.	Normals, 1888-1915.		1923-1938.	Normals, 1888-1915.
Jan.	2·47	1·95	July	3·2	2·74
Feb.	2·04	1·88	Aug.	3·14	3·28
Mar.	1·77	2·06	Sept.	2·81	2·08
Apr.	1·92	1·70	Oct.	3·48	2·66
May	2·41	2·09	Nov.	2·56	2·44
June	2·21	1·80	Dec.	2·50	2·66
			Year	30·51	27·44

RAINFALL AND SUNSHINE.

Table V., for the shorter period, also reveals changes in rainfall as compared with conditions during the " normal " period. Total precipitation has increased by slightly over three inches, the greatest increase falling in the months of September and October. A few months, March, August, and November, are actually drier. Details for the months during the period are found in the Appendix.

On the average, precipitation in some form, rain, hail, or snow, falls every second day, 184 days out of 365.

TABLE VI.

BRIGHT SUNSHINE (TRAINING COLLEGE ROOF).

	Length of Day.	Hours per Day.	Monthly.	Per cent.
January	7·50 hrs.	1·83	56·6	24
February	9·43	2·66	74·5	28
March	11·75	3·38	104·8	29
April	14·14	4·4	132·0	31
May	16·31	5·13	159·1	31
June	17·53	6·12	183·6	34
July	16·98	4·87	151·1	28
August	15·07	4·82	149·5	32
September	12·75	4·06	121·9	32
October	10·37	3·24	100·5	31
November	8·16	2·17	65·1	27
December	6·87	1·36	42·1	20
Year	12·25	3·67	Total 1340	30

From the end of October until the beginning of the first week in March rain falls, on the average, 5 days in the week. This period coincides also with the period of minimum sunshine (see Table VI.), and includes the weeks of maximum precipitation, weeks commencing October the 29th—·68 in., and December 3rd—·78 in.

During March, particularly after the equinox, the weather gradually clears, rainfall decreasing to 4 days of the week, lessening in amount—1·77 in. —and having increased sunshine. The drier sunny conditions permit of a start being made with cultivation in the garden. During the second and third week of April there occurs " normally " a bright, sunny, dry spell—with a rainfall frequency of about 3 days per week, and the total precipitation, in light showers, amounting on an average to ·3 in. per week. The preparation of seed beds and sowing go forward rapidly at this time. In June we have not only the longest hours of sunshine, but also the greatest percentage of the possible; with rain falling on approximately 3 days per week only, and not in excessive amount (2·21 in. for month). After June rain increases in amount and frequency, and towards the end of August, on the average falls on 5 days in the week. The total amounts for July (3·2 in.) and for August (3·14 in.) are rather heavy. The amount of sunshine is rather low in July (28%), but rises again during August (32%). These frequently disappointing holiday months are often followed by belated " summer " in September, when the frequency of rainfall is as low as 3 days per week; some years may have null for the first 3 weeks, but the average fall is only ·4 in. per week. At the end of the month the weather breaks, rainfall becoming heavier and the sunshine shorter, relatively and absolutely. (See figures.) November is likely to give the first snowfall, but it lies scarcely longer than the day on which it falls. Normally, snow falls on two days in December and lies for 3 or 4. Similar falls occur each month until March. In April it usually melts on the day it falls. Snow is not unknown in May, but seldom lies.

TABLE VII.

SNOW (1923-1938).

Total for period.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Days falling	34	31	37	6	3	—	—	—	—	2	12	31
Days lying	57	35	44	5	—	—	—	—	—	—	9	57
Average per year.												
Days falling	2	2	2	2 days in 5 yrs.	1 day in 5 yrs.	—	—	—	—	1 day in 8 yrs.	1	2
Days lying	3-4	2	2-3	1	—	—	—	—	—	—	—	3-4

Fog occurs most frequently in November and December and cuts down the already short hours of daylight, the hours of bright sunshine only amounting to about 25% of the possible.

Thunder is practically limited to the six months commencing May, and the greatest number of occurrences falls in July and August.

DUNDEE AND DISTRICT.

In relating Dundee to the surrounding district, instrumental readings are supplemented by other observations. For example, a light covering of snow may persist on the low hills behind Newport across the river, when ploughing may be going forward on this side.

The golfer will note that the low-lying sandy stretches or links along the East coast have much sunshine and relatively small rainfall, cf. figures for Arbroath (24·20 ins. and 1,504 hours) and Carnoustie (26·1 ins. and over 1,410 hours).

Table VIII.

District Rainfall.

	Dundee (Mayfield). 147 ft.	Arbroath. 93 ft.	Carnoustie. 39 ft.	Monikie. 494 ft.	Clatto. 498 ft.	Crombie. 528 ft.	Lintrathen. 700 ft.	Perth. 76 ft.
1938	31·78 in.	28·32	26·18	36·05	34·77	37·89	40·66	—
1937	33·65	32·38	29·04	37·78	—	39·3	34·38	—
1936	28·59	23·95	23·94	30·43	—	33·18	32·23	—
1935	29·03	26·55	25·15	33·89	—	34·09	35·07	—
1934	30·32	27·66	26·11	35·02	—	38·23	37·44	—
1933	23·35	17·87	—	25·57	—	28·08	28·19	—
1932	28·21	26·82	—	32·79	—	35·39	35·77	—
1931	34·47	29·27	—	35·28	—	35·48	40·05	—
1930	33·63	32·00	—	38·58	—	41·26	40·85	—
Aver 8 yrs.	30·34	24·20	Av. 5 yrs. 26·1	33·97	—	36·21	36·08	—
Normal—	27·44							30·79

Table IX.

Sunshine (Annual Totals) Hours.

	Dundee.	Arbroath.	Carnoustie.*	Leuchars.	St. Andrews.	Perth.
					Averages.	
1938	1404·8	1510·9	1428·4			
1937	1246·4	1359·9	1275·9	1921-35	1913-35	1914-35
1936	1367·0	1548·3	1404·8	1470	1412	1357
1935	1387·0	1549·5	1429·1			
1934	1417·9	1600·8	1496·6			
1933	1428·0	1551·3				
1932	1371·6	1506·3				
1931	1278·7	1407·6				

*Recorder partly obstructed.

On leaving the coast and proceeding higher and westwards we find an increase in rainfall, as shown by the readings taken at the city reservoirs. See Tables No. VIII. and IX.

Similarly, going west up-stream, Dundee (27·4 ins. and 1366 hrs. annually or 3·74 hrs. daily), and Perth (30·8 ins. and 1357 hrs. or 3·71 hrs. daily), show increasing rainfall and (slightly) decreasing sunshine.

Weather and Agriculture.

The sheltered Carse, facing south, with its heavier alluvium, may be called, somewhat extravagantly, a land of "milk and honey," with its dairy herds, its fruit orchards of apples, pears, and plums, and its hives. Bee hives are within a half-mile of the city centre. Calm, warm, sunny afternoons in the last days of May or in the beginning of June frequently induce "swarming." At Mayfield a fig tree, out-of-doors, produces fruit. In contrast, the higher ground to the north is given more to rasp cultivation and to carrying beef cattle.

The soils to the east and north are somewhat lighter, and work is not so often held up by weather conditions. Soil differences, as well as differences due to altitude, aspect, and rainfall, cause some variation in the times of operations. Rainfall, frost, and snow vary a great deal from year to year, and with temperature conditions will directly influence the speeding up or the retardation of cultivation and subsequent growth. Ploughing and carting of dung can go forward immediately the soil is cleared—from September

onwards. Potatoes are lifted in October; and the sowing of winter wheat usually completed by the end of November. Cultivation goes on throughout the winter months whenever there is open weather. The drying conditions of March and April allow harrowing for the preparation of the seed bed and the sowing to proceed. Spring wheat may be sown by early March; oats and barley in March and, at latest, mid-April. By the end of April potato planting will probably be over, and turnips will be sown in May. A hay crop will be taken in July. The warmth and rains of July and of August still encourage growth, but usually some of the harvesting has been started by mid-July, e.g. early wheat. The main wheat crop will be taken by mid-August. Shortly after this barley and oats should ripen sufficiently, and in the drier days of September cutting and leading-in of these should be completed.

In addition to readings taken at Mayfield, figures were supplied by the City Water Engineer's Department; Park Superintendent, Arbroath; and Burgh Surveyor, Carnoustie, and permission was granted by the Controller, H.M.S.O., to quote "normals" and "averages" compiled by the Meteorological Office.

IV.

THE FLORA OF THE DUNDEE DISTRICT

BY

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THE whole of Angus, the esturine region of the Tay known as the Carse of Gowrie with the extension of the Sidlaws into Perthshire, the North of Fife to the East Neuk—the Southern shore of the Firth of Tay, these are the limits set for the Dundee district. In this survey opportunity has been taken to call attention to the flora of the Esk basin, which belongs properly to Mearns. This favoured corner escaped notice in the Handbook of 1912 and only received passing reference in the Aberdeen Handbook of 1934.

It is from the ecological study that the best impression of the vegetation of any tract of country is obtained. In the ecological study of plants in this country first place must be allotted to the pioneer work of Robert Smith. In 1898 and 1901 " The Plant Associations of the Tay Basin " were published, and in 1904-1905 Parts III. and IV. of the Botanical Survey of Scotland dealing with Fife and Forfar were completed by William G. Smith on the notes left by his brother. Within the region under review the vegetation is grouped into four well marked botanical regions, viz., The Maritime Region, The Regions of Cultivation of Farmland, Woodland, and Moorland. These divisions correspond to those set out in 1813 by the Rev. J. Headrick in his " Survey of Angus," namely, the Coast, the Sidlaw Hills, the Valley of Strathmore, and " that portion of the Grampian Mountains which it (Angus) includes."

The maritime region with its irregular coast line shows a varied vegetation. Sandy shore with fringing sand dunes occurs at Montrose, Lunan Bay, Arbroath, Easthaven, Barry, Tentsmuir, St. Andrews, and Largo. This is interrupted by bold cliffs and rocks at St. Cyrus, from Montrose to Arbroath and along the Fife coast. Inland the sand dunes give place to grass dunes with golf courses at Montrose, Carnoustie, Monifieth, and St. Andrews, while grassy heath still persists at Barry and Tentsmuir. Mud flats with salt marsh plants occur in the tidal esturies of Montrose Basin, in the Tay at Invergowrie and Kingoodie, Balmerino and Tayport, and on the Eden from Guardbridge. The reputation of St. Cyrus as a botanical resort is based on the list of plants found on the calcareous material of the Upper Old Red Sandstone. These include Fumaria densiflora, Arabis hirsuta, Helianthemum chamaecistus, Viola hirta, Silene nutans, Hypericum perforatum, Trifolium striatum, Ononis repens, Astragulus danicus, Vicia lutea, Carlina acaulis, Campanula glomerata, Origanum vulgare, Phleum arenarium, Avena pratensis, Avena pubescens. Near Montrose Carex divisa and Koeleria arenaria occur together. A few of the more local or noteworthy plants recorded from North Fife are Silene anglica, Stellaria aquatica, Erodium maritimum, Vicia Orobus, Filago gallica, Malaxis paludosa, Corallorrhiza trifida, Goodyera repens, Juncus filiformis, Juncus subnodulosus, Sesleria coerulea.

At one period Fife and Angus were covered with forest extending up to the edge of a treeless region in the mountains. The area north of Strathmore still shows a more varied woodland than any other region, presenting as the elevation increases from the plain a passage from mixed deciduous wood up the main streams where oak becomes dominant. Above 900 feet the oak disappears leaving birch and rowan the dominant trees in the subalpine woods near the moorland. Seedlings of these trees are found up to 1,250 feet over Cairn O'Barns between Glen Clova and Glen Prosen. Coniferous wood occurs near sea level at Barry and Tentsmuir, at Montreatmont near Brechin, up to Balnagairn Wood near the head of Glen Clova, and the Larch and Scots Pine wood in Caenlochan in Glen Isla at 1,500-2,000 feet, the highest limit of woodland.

The region of cultivation has been introduced by man into the pre-existing vegetation of woodland. Nearly five-sixths of Fife is under cultivation, a larger proportion than any other county in Scotland; in Angus less than half the total area is farmland, while the Carse of Gowrie is renowned for its farming. Wheat is grown in the narrow coastal strip, in the Carse of Gowrie, portions of Strathmore reaching 400 feet, the lower southern slopes of the Sidlaws reaching 660 feet, and the Howe of Kinnaird. An upper zone of cultivation without wheat reaches the 1,000 foot contour.

One of the classical localities for plants in Angus is the chain of lochs and marshes on the Lunan. Rescobie and Balgavies, about 3 miles to the east of Forfar, attracted Don and Gardiner and at a later date Abram Sturrock and J. Knox. In addition to containing rare plants, the marshes round these lowland lochs contain many of the reed-swamp plants found in the Tay. Outstanding plants are Caltha radicans, Ranunculus aspergillifolius, and Lastraea (Dryopteris) thelypteris in the neighbouring marsh at Restennet, while in the Carse Oenanthe fistulosa, Cynoglossum officinale, and Catabrosa aquatica are local rarities.

The moorland region lies mainly on the hills and mountains above the region of cultivation and is divided into two groups by Strathmore. From Perth the Sidlaws bound the Carse of Gowrie on the north, and increasing in height to 1,399 feet on Auchterhouse form the southern rampart of Strathmore. The northern heights of the lowlands have steep, step-like slopes intersected by dens to the south-east and a long gentle slope to the north-west. Grass association or hill pasture cover the slopes of the andesite and sandstone hills of Perth, while heather clothes many of the summits, especially on the basalt-sandstone area to the north of Dundee, e.g. Gallow Hill, Craigowl, and Auchterhouse Hill, while, where the soil is poorly drained, peat may form but is nowhere extensive. Whin in distribution follows the andesitic hills and basalt outcrops and is abundant up to 600 feet, rising to 1,000 feet on Kinpurney. Above this is a well defined zone of bracken extending up to 1,500 feet in places.

In the parish of Lundie, near Newtyle, on the south side of the Sidlaws, are two small lochs only 1 mile apart. Abram Sturrock first called attention to the difference in the vegetation of these two lochs. The Round Loch lies in farm land with trees and undergrowth on the northern shore and the shore line is obscured with reed swamp. The Long Loch is treeless and is without fringing swamp and contains Lobelia, Subularia, and Isoetes. The difference between the two is remarkable and is due to the difference in supply

of mineral salts in the water. Lowland loch and marsh, grassy moor and oak wood are all abundantly supplied with available mineral salts, highland loch and bog, heather moor and pine wood represent vegetation with a meagre supply of available salts.

Strathmore to the north is bounded by the southern slopes of the great highland plateau of the Eastern Grampians rising to an average height of 3,000 feet, from which spurs lead down intersected by Glen Isla, Glen Prosen, Glen Clova, and Glen Esk. The moorland of the Grampians includes both subalpine and alpine forms of vegetation. Grassy foothills with associations similar to those of the Sidlaws are succeeded by heather moor coincident with the occurrence of mica schist and quartzite and quartzite schist. Above this is the upper hill pasture which may be looked upon as grass heath with admixture of mountain species or Vaccininium with a preponderance of lower range plants.

The arctic alpine region is clothed with grasses much mixed with blaeberry and little heather where the drainage is good or with poor heather mixed with blaeberry on deep peat in hollows. At the same time the geology of the plateau is favourable to the formation of moist and sheltered crags, particularly the mountains of Clova and Caenlochan whose wealth of rare species was first made known by George Don and later by William Gardiner. These characteristic arctic-alpine plants occur chiefly on the exposed cliffs below the plateau and this is the pilgrimage of each succeeding generation of botanists to visit Lychnis alpina, Astragalus alpinus, Oxytropis campestris, Erigeron alpinus, Saussurea alpina, Lactuca alpina, Gentiana nivalis, Bartsia alpina, Alopecurus alpinus, Phleum alpinum, Poa alpina, Carex Grahami, Carex Sadleri, Carex rariflora, Carex Halleri, Carex Lachenalii, Carex rupestris, Cystopteris montana, Woodsia ilvensia, Woodsia alpina, Athyrium flexile at home.

" The Flora of Forfarshire " published in 1849 by William Gardiner is the only Flora and the earliest record of the plants in the County, save Don's list of " Native plants in the County of Forfar " printed as an appendix to Headrick's " Agriculture of Angus or Forfarshire " (1812). H. C. Watson in " the New Botanist's Guide " (1837) gives a list of the rare plants to be found in Forfarshire. Edward Muir writing the chapter on Botany in Alex. J. Warden's " Angus or Forfarshire " enumerates " a few of the rarer and more interesting plants " ; a local list for Arbroath was published as " the Flora of Arbroath " in 1882, and there is the account of " the Flora of Forfarshire " by James Brebner in the Handbook for the Dundee Meeting (1912). The records for the Carse of Gowrie are to be found in " the Flora of Perthshire " by Dr. Buchanan White edited by Professor Trail (1898). Watson, in the Guide referred to, gives a list of rare plants of Perthshire and of Fifeshire, and " a list of the Flowering Plants and Ferns of Fife and Kinross " by William Young occupies the major portion of the centenary number of " the Transactions of the Botanical Society of Edinburgh " (1936), and from this the records of the North of Fife plants are obtainable.

Behind these larger works lies the organised and devoted efforts of the members of the Natural History Societies situated in the area. These workers laid the foundations of our knowledge of the flora, and it is very right and proper that tribute be paid to their excellent work and that the lasting debt be acknowledged. To take but one instance—in " the Flora of Perthshire "

568 plants are recorded for the botanical district of Perthshire called Gowrie, and so thoroughly had the work been done that only one additional plant to be found in Gowrie occurs in William Barclay's "Additions to the list of Perthshire plants" published in 1912, and not one reference to a Carse plant appears in Professor Mathews' "Recent Additions to the List of Perthshire plants" printed in 1927.

The names of the societies working within or adjacent to the area are given in geographical order along the coast, starting from the North, in the following list:—

Town.	Name of Society.	Dates.	Membership in 1889.
Montrose—	The Natural History and Antiquarian Society of Montrose	1836	100
	Montrose Scientific and Field Club	1882-1890	10
Arbroath—	Arbroath Horticultural and Natural History Society	1880-1905	68
	Arbroath Scientific and Natural History Society	1905-1936	
Dundee—	The Gleaners of Nature	1828-1835	
	The Dundee Naturalists' Association	1847-1849	
	The Dundee Naturalists' Society	1874	154
	The Dundee Naturalist Field Club	1868-1884	
	The Dundee Working Men's Field Club	1885-1910	20
Perth—	Perthshire Society of Natural Science	1867	260
Largo—	Largo Naturalists' Society	1863-1894	24
Kirkcaldy—	Kirkcaldy Naturalists' Society	1882	136
Dunfermline—	Dunfermline Naturalists' Society	1902	
Alloa—	Alloa Society of Natural History, Science, and Archaeology	1865	
Stirling—	Stirling Field Club	1878	93
	East of Scotland Union of Naturalists' Societies	1884-1894	785

Thus at one time or another there were 16 societies working in the pursuit of Natural Science; to-day there are but seven and of these, two persist in little more than name. In these days when the interior of the cinema and the motor car are preferred to the open country, but while the names of those who did so much for Natural Science are still remembered, it is most fitting to record the debt to their services.

Among the celebrated botanists connected with Angus two names stand out prominently from the rest: Robert Brown, who outstripped all his contemporaries in the extent and accuracy of his knowledge and in his comprehensive views of affinities in the vegetable kingdom, made some first records for his native county before he travelled forth; George Don, whose discoveries of new plants are larger and more important than those made by any other British botanist. Nor must we forget Lady Jane Carnegie, who compiled a herbarium between 1834-1840, gifted later to the Arbroath Society and now in University College, Dundee. William Gardiner, founder of "The Gleaners," is the author of "the Flora of Forfarshire" (1849). In it appear the names of many workers who supplied Gardiner with his stations, and among these names are included the Rev. J. S. Barty

of Ruthven; Archibald Bousie, gardener at Pitfour; Alexander Croall, a joiner, who became Curator of the Smith Institute at Stirling; J. Cruickshanks; the Rev. J. O. Haldane of Kingoldrum; John Laing, gardener at Kinnaird; A. Kerr, and G. M'Farlane. Professor George Lawson contributed papers on Forfar and Fife plants before he went to Canada. Later workers include James Brebner, John Knox, and Abram Sturrock. Nor were the flowerless plants neglected. Thomas Drummond, gardener at Invereighty, made the earliest contribution to the study of the mosses, to be followed by William Smith of Arbroath who worked with the Rev. John Ferguson of Fearn, author of a "List of Forfarshire Mosses," and later John Fulton, a jute worker, who wrote the article on "the Mosses of Forfarshire" for the 1912 Handbook. The Rev. John Stevenson of Glamis published his "Mycologia Scotia" in 1879, and the marine algae are in the safe hands of James Jack, Arbroath. To these should be added the names of Professor Sir Patrick Geddes, Robert Smith, pioneer in ecology, Marcel Hardy who extended his work, and George West associated with the Scottish Lake Survey, all of whom were associated with the Botany Department, University College, Dundee.

The earliest account of the Carse is in "the Flowering Plants of the Carse of Gowrie" by Colonel H. M. Drummond Hay (1874), and there are numerous papers by William Barclay and Robert Dow, Longforgan, in "the Transactions of the Perthshire Society of Natural Science." R. H. Meldrum specialised on the Carse mosses, publishing a "Preliminary List of Perthshire Mosses" in 1898. Dr. Buchanan White published a "Preliminary List of Perthshire Fungi" in 1880, and Charles M'Intosh of Inver and James Menzies also worked with these plants.

The first list of Fife plants is by the Rev. John Anderson of Newburgh and appears as an appendix to "Fife Illustrated" by John M. Leighton (1840). George Lawson published a "List of Rarer Flowering Plants observed in Fifeshire in 1846-47" in the Phytologist (1848). Charles Howie, author of "the Moss Flora of Fife and Kinross" (1889), provided a list of plants for "The Shores of Fife" by W. Ballingall (1872). The Rev. Walter Wood in "The East Neuk of Fife" (1876) and Dr. Alex. Laing in "Lindores Abbey and the Burgh of Newburgh" (1876) give local lists of flowering plants. The Rev. Mark Anderson of the Town Church, St. Andrews, gathered numerous Fungi and G. W. Trail made a collection of the main Algae. Dr. John Wilson, first lecturer in Botany, and Professor R. A. Robertson did valuable work within the University. John Smith, born at Aberdour in 1798, was educated at Pittenweem and for 30 years held the post of Curator of the Royal Botanic Gardens, Kew.

One other name calls for mention, that of Professor James William Helenus Trail of Aberdeen. Throughout the records his name constantly appears assisting and encouraging the local workers.

V.

ANIMAL LIFE IN THE DUNDEE DISTRICT

BY

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ON our local fauna no comprehensive work as yet exists, and this article can present but an outline of its outstanding features gathered from many scattered references. For those interested, however, the sources of detailed information are available in bibliographical and species indexes, and in collections of specimens, lodged in the Natural History Department, University College, Dundee.

HISTORICAL.

Earlier Literature. Our earliest source book is a little volume, "The County of Angus," published in 1678 by Robert Edward, Minister of Murroes (1), which contains scattered bits of zoological information. The next work, "General View of the Agriculture of the County of Angus, or Forfarshire," by James Headrick, Minister of Dunichen, is an important source book (2) for it deals with fisheries, native animals, farm stock, etc., and also includes a valuable appendix, "Account of the Native Plants in the County of Forfar, and the Animals to be found there," by that fine naturalist, George Don of Forfar. The third book, "A Fauna of the Tay Basin and Strathmore," by J. A. Harvie-Brown (3) contains many references, to vertebrates and birds especially. The fourth volume is the British Association's "Hand-book and Guide to Dundee and District" (4) with its articles on fisheries, whaling, fossils, birds, and on celebrated local naturalists.

The Earlier Naturalists. Patrick Blair (1666 ?-1728) was a Dundee "Surgeon-Apothecary" and Fellow of the Royal Society. Though primarily a botanist, he is of interest to zoologists because he was the first in Britain to dissect an elephant. The specimen, belonging to a travelling show, died at Broughty Ferry in 1706, and Blair's accurate paper on it, *Osteographia Elephantina*, was published in the "Philosophical Transactions of the Royal Society of London," 1710-12. His life, which he nearly forfeited through his adventure with the Jacobite Rising in 1715, has been well told by A. P. Stevenson (4).

George Don (1764 ?-1814), the son of humble parents, was also primarily a botanist. His life of many vicissitudes, traceable mostly to his craving for pursuing untrammelled his love of natural history, has been feelingly recorded by G. C. Druce (4). Don's faunistic contribution to Headrick's book (2) is remarkable and throws interesting side-lights on former local faunistic conditions. It comprises some 810 species, classified on the Linnaean system : 72 zoophytes (coelenterates, sponges, polyzoans and "infusoria") ; 26 mammals ; 166 birds ; 30 amphibia (true amphibia, reptiles, and certain

fishes); 64 fishes; 406 insects (true insects, crustacea, millipedes, centipedes); and 46 worms (nematodes, flatworms, annelids, molluscs, ascidians, sea anemones, echinoderms). Regarding mammals the pine martin, polecat, and stoat were rare, the badger "rather rare," the weasel "not unfrequent," and the hedgehog "formerly rare—but of late years it has appeared in tolerable plenty." The black rat was the only species in the town of Forfar, and not rare in inland parts, while the brown rat was common in the seaports. The rabbit was rare, "perhaps hardly a native." The red, fallow, and roe deer were all rare. Regarding birds, Don records the "erne"; of eagles the sea, golden, ring-tailed, and black; the kite; the common honey and moor buzzards; the gosshawk; the gentle falcon; the hobby; the raven, jackdaw and Cornish chough; the blackcock was rare, the ptarmigan occurred at Clova, and the red grouse was "becoming very rare of late years" and was threatened with extinction. As well as the common toad and frog, there was the edible frog "about the lakes, but rather rare," and "the grand frog of Lightfoot," three times the size of the common frog and possibly a rare native of the salt marshes.

Patrick Matthew (1790-1874), of Gourdiehill in the Carse of Gowrie, was an interesting personality. His book, "Naval Timber," 1831, contained a remarkable but completely undeveloped suggestion anticipating by over twenty years Charles Darwin's highly developed hypothesis of natural selection. One characteristic passage illustrates Matthew's conception: "As the field of existence is limited and preoccupied it is only the hardier, more robust, better-suited-to-circumstance individuals who are able to struggle forward to maturity . . . the weaker, less circumstance-suited, being prematurely destroyed" (see W. T. Calman, 4; and L. Melville, 5).

Charles Lyell (1797-1875) of Kinnordy, one of the greatest figures in the heroic age of geology, is remembered by zoologists for his influence on palaeontological studies (see p. 32).

John Hood (1831-1914) was by trade a turner in Dundee, but by nature was a naturalist. Concerning his career we cannot do better than quote Dr. William T. Calman (6). "Mr John Hood . . . was well known to many zoologists and microscopists as a collector of the more minute forms of freshwater life and especially the Rotifera. The study of these attractive little animals was the hobby of his life, and though he published little under his own name, he gave very important assistance to many other workers. . . . He was especially successful in obtaining new and curious forms of the sessile Rotifera forming the group Rhizota. . . . His skill is shown by his making his own microscope. In his later years . . . he was in straitened circumstances, and sometimes perilously near actual privation. Only a year ago a small pension from the Murdoch Trust . . . brought ease of mind and some comfort to his last days. Probably very few of his numerous correspondents knew him personally, but those who did know that he represented a particularly fine type of the 'working-man naturalist,' a type . . . . which was more characteristic of the nineteenth century than it promises to be of the twentieth." He was a Fellow of the Royal Microscopical Society for 33 years, and his only major paper, "On the Rotifera of the County Mayo" (7), written, as he says, "under the guidance of Professor D'Arcy Thompson," deals with about 220 species (see also p. 46). His photograph, showing him bearded and wearing a black skull cap, reminds one strongly of Darwin.

Local Institutions. The Central Museum and Art Galleries of Dundee house Arctic animals, including two fine musk-ox, all obtained from former Dundee whaling skippers, and the skeleton of a hump-backed whale, *Megaptera longimana* (Rudolphi), the "Tay Whale," fatally wounded in the Tay, Jan. 1, 1884, and finally taken off Kincardineshire (White, 8). There is also a fine assemblage of local fossil fishes collected by Lord Kinnaird last century. The Dundee Naturalists' Society possess a small representative collection of local birds and are also the fortunate owners of some remarkable local fossils, including the giant primitive arachnid, *Pterygotus anglicus*, and certain primitive fishes (see p. 33). The Natural History Department of University College, Dundee, was founded by Professor D'Arcy W. Thompson and directed by him for over thirty years. Its general museum, including extensive named collections of most invertebrate groups, is his work, and its most notable trophy, a skeleton of Steller's sea-cow, *Rhytina stelleri*, was brought by him from Behring Island in 1898. Of his many activities in Dundee mention may be made of his long-continued researches on fisheries, and of the publication of his notable work "On Growth and Form" (9). The short tenure of his successor, Professor J. F. Gemmill, was marked by work on the wheat bulb fly (p. 45). Since Professor Gemmill's death the main researches in the department, under Professor Peacock, have related to the biology and cytology of animal parthenogenesis, and, recently, progress has been made in a local faunistic survey, towards which end a Field Station has been established at Glen Doll, Angus. The Art Gallery and Museum, Perth, is the headquarters of the Perthshire Society of Natural Science and houses the Society's well-displayed representative collections of the fauna, flora and petrology of Perthshire.

Whaling. Dundee was long recognised as one of the main centres for Arctic whaling and sealing, but these characteristic activities ceased in the Spring of 1914, when the last northern voyage was made by two whalers. Whale and seal oils were formerly much in demand as illuminants, and are still used locally for processing jute. High (4) states that whereas in 1867 the number of vessels engaged was twelve, representing a capital estimated at £200,000, the number in 1912 had fallen to eight, only two of which had made the northern venture that season. The decline of the industry was primarily due to the ruthless and uncontrolled slaughter of the Arctic whales and seals by the whalers of several nations, which brought about the extreme scarcity of the animals. One would have thought that, faced with failure in the north, the Dundee whaling business would have made a bid for a share in the prosperity of the Antarctic fishings. This, however, was never done, whether through lack of enterprise, or because local capital found greater profit elsewhere, it is difficult to say.

The Fauna of the Past.

The Palaeontological Features are of more than local interest, for the red sandstone fossils have afforded invaluable material for studies in the evolution of fishes and vertebrates since they excited the attention of such bygone eminent geologists as Roderick Murchison, Dean Buckland, Charles Lyell, Hugh Miller, and Louis Agassiz, the great Swiss naturalist. Some aspects of this history have been admirably recorded by the late James B. Corr (10, 12).

Certain very remarkable and enigmatic fossils from the Lower Old Red Sandstone of Balruddery and Carmyllie, Angus, and of Wormit Bay, Fife, were known to the Forfarshire quarrymen as " Seraphim," because of the resemblance of their elliptical scale-like markings to the wings of cherubs. Fragmentary remains were of frequent occurrence at Balruddery, and up to the time of Agassiz's visit to the Den no geologist had ventured to offer an opinion on them. Hugh Miller (11) relates how the great Swiss naturalist examined a group of dislocated fragments in the presence of Charles Lyell and other eminent geologists ; how, as his eyes brightened, he said, " I will tell you what these are,—the remains of a huge lobster " ; and how he arranged the fragments so that the general outline of an entirely new crustacean gradually dawned upon his admiring friends. This animal, *Pterygotus anglicus*, however, is not a crustacean, but an eurypterid, a primitive arachnid, the modern forms of which include the scorpions and spiders. The Dundee Naturalists' Society, as well as possessing fragments of this type, has a magnificent specimen, over five feet long, from Carmyllie, and also a fine specimen of a closely related form, *Stylonurus*, apparently undescribed and probably well worth an expert's consideration.

In a quarry near Glamis a workman discovered the first local fossil " pre-fish ". It was sent to Lyell at his home at Kinnordy, who, in turn, sent it to Agassiz in Switzerland. Agassiz named and figured the specimen as *Cephalaspis Lyelli* ; it is now in the British Museum collection. This creature is now regarded as a primitive vertebrate, jawless, with a fish-like body, and a large head covered by a large bony shield. The same form was found in the Balruddery rocks.

Fossils of fish-like forms higher than Cephalaspis have been found in the Upper Old Red Sandstone of Dura Den, Fife. From their size and peculiar appearance, they were originally supposed to be beetles. The creature, called *Bothriolepis hydrophila*, was " essentially an elongate oval bony box, about 3 or 4 inches in length with a pair of long paddles movably articulated with its sides " (Woodward, 4).

Still higher forms, and definitely fish, are several species of " presharks," Acanthodia, from the Lower Old Red Sandstone at Farnell near Montrose, Turin Hill near Forfar, Carmyllie near Arbroath, Balruddery Den near Dundee, and on the Tay at Wormit Bay, Fife. The name refers to the characteristic large front spines supporting all the fins except that of the tail, a feature which sharply separates them from all other fishes. They are the most archaic and earliest of jawed vertebrates. The most successful of local workers in the group was James Powrie of Reswallie, " whose extensive collection of local specimens, unrivalled for the beauty and rarity of the specimens, is now permanently located in our National Museum at Edinburgh " (Corr, 12). Much of Powrie's material came from Turin Hill and the Dundee Naturalists' Society possesses certain specimens given by Powrie himself. Powrie's and the Society's specimens are re-described by Professor D. M. S. Watson in his recent authoritative monograph (13), from which we note that one of the Society's specimens is of particular interest because it elucidates the structure of the nostril.

Belonging to another evolutionary line is *Holoptychius nobilissimus*, definitely a fish and found in the Upper Old Red Sandstone at Clashbenny Quarry. Here was obtained the type specimen, now in the British Museum,

as well as other species described by Agassiz. These fishes are of the fringed-finned group (Crossopterygia), had heads heavily armoured with thick bony plates, and belong somewhere near those forms which gave rise to the earliest lung-breathing fishes, from which sprang later kinds of lung-breathing fishes, as well as primitive amphibians that were becoming adapted to land life.

The yellow sandstone of Dura Den, Fifeshire, also yielded species of holoptychians and other crossopterygians, and a species of lung-fish, *Phaneropleuron Andersoni*. The number of species of fishes and the abundance of individuals found at Dura Den give evidence of some catastrophe overwhelming them in shoals, but the nature of the catastrophe is not known. (See Craig and Balsillie, 4.) Additional interest is attached to these crossopterygian fossils because of the recent capture, off the coast of Africa, of a " living fossil " relative, five feet long, belonging to the coelacanths, a group hitherto supposed to have become extinct some 50 million years ago (Smith, 14).

That the Tay fauna was once comparable to that now existing in the Arctic of West Greenland is shown from the remains of shells, crustacea, starfish, mammals, etc., found in the clays and sands associated with the deposits of the raised beaches, terraces or platforms, considered to mark pauses in the uplift of the land since the Ice Age. The local deposits of glacial origin are principally those laid down during the last stages of the melting and retreat of the ice (Balsillie and Craig, 4 ; C. F. Davidson, 15). The skeleton of the north Atlantic ringed seal (*Phoca hispida*) was found in the clays of the 100-foot terrace at Cupar Muir ; the humerus of the same species, as well as numerous specimens of a starfish, *Ophiolepis gracilis*, in the clay at Seafield ; and certain molluscan shells, such as *Yoldia arctica*, *Pecten groenlandicus*, *Tellina calcarea*, and *Thracia myopsis*, in the clays of Errol, Barry and Arbroath. In the 50-foot terrace at Polgavie and at Inchture in the Carse of Gowrie numerous specimens of *Scrobicularia piperata* have been obtained.

The Arctic clay of Inchcoonans, Errol, provided the finest fauna of its kind in the East Coast (Davidson, 15). It comprises 22 species of mollusca, including the edible oyster, a mussel, and 2 species of rock-borers ; 22 species of lower crustacea (Entomostraca), with *Cythere mirabilis* as the dominant form, and one barnacle ; 1 species each of starfish, worms, and polyzoa ; 4 species of foraminifera ; and one mammal, the common seal. The fossils, e.g., oyster, found in the uppermost beds were distinctly less Arctic species, indicating that conditions were gradually becoming warmer, for the oyster to-day does not extend north of the Arctic Circle.

The flora and fauna of the higher deposits of peat and estuarine clay are those of to-day.

The presence of horses at an early age in the development of Scotland is attested by remains found in different part of the country, including the Angus marl mosses (Lyell, cited by J. Ritchie, 16). The remains are those of a small horse, called by Ewart the " plateau type " (*Equus agilis*), which roamed the plains of Italy and France. It must have resembled the modern Iceland pony, which itself is characteristically Ewart's Celtic pony (*Equus agilis celticus*). The presumptive evidence is strong that this small horse was one of the domesticated animals of neolithic man in Scotland, which he reached after the Glacial Age, but it is uncertain whether the Scottish relics pertain to animals which came in the train of the post-glacial neolithic

colonizers or to animals which certainly lived in Scotland before the advent of these colonists.

Animals More Recently Extinct. Of the giant wild ox of Europe, the aurochs (*Bos primigenius*), a horn core and skull fragment were found at Mugdrum, in north Fife (John Ritchie, 17); and of the "Irish" elk (*Alces alces*) remains have been obtained in the Angus marl beds. This latter animal almost certainly persisted in Scotland beyond the ninth century, its extinction being most probably due to the destruction of the forests, its natural haunts, a destruction begun by the Romans (James Ritchie, 16).

Animals Recently Extinct. The last killing of the wolf in Angus occurred about 1680, but the species probably lingered until 1743 in wilder regions of Scotland (James Ritchie, 16). The pine marten was regarded as rare by Don in 1813; he records one as being shot in 1808 near Glamis. The last record is dated 1860 (James Ritchie, 16). The polecat or foumart was also mentioned as an Angus rarity in 1813 by Don, but it was common in the Tay basin in 1820 and became extinct before 1882, according to Drummond-Hay (see Harvie-Brown, 3). It still lingers in the wilder northern highlands of Scotland. The extinction of both these has come about by their being victims of the fur trade in earlier times, and, with the spread of agriculture, by being classed as vermin (James Ritchie, 16). The badger was abundant in the Tay basin about 1820-1824 but evidently became extinct towards the close of the same century (Drummond-Hay, see Harvie-Brown, 3). The black rat, the plague carrier, in Don's day, was the only rat known in Forfar as late as 1813, but whether it still persists inland is unknown, though occasionally fugitive specimens from ships are caught at Dundee docks.

Mammals.

Aberdeen-Angus Cattle. This breed of cattle from Aberdeen, Angus, and the adjoining counties is characterised by hornlessness, an almost uniformly black colour, and such a marvellous quality of flesh that it is doubtful whether any other beef is its equal. The animals are known as "humlies," or, more locally, as "Angus doddies." The origin of the polled condition and colour is obscure, though black cattle without horns have been known since the middle of the sixteenth century. The genetics of the breed have not been determined and any such study would be difficult because in both ancient and modern times crossings with other breeds have been made. So long ago as 1813 Headrick (2) remarked that the great proportion of permanent stock were "humlies," but that the county possessed various breeds of cattle of differing qualities, and that little attention was paid to selection. However, at the beginning of the nineteenth century the breed was greatly improved by Hugh Watson of Keillor, Angus, who followed the intensive inbreeding and selective methods of the great English farmer Bakewell. "While, perhaps, collectively the greatest part of the early work of improving the breed was carried out by Forfarshire breeders, individually they were all eclipsed by William M'Combie of Tillyburn, Aberdeenshire, who did more than any other person to secure for the breed its world-wide reputation" (Wallace and Watson, 18). The word "humlie" refers to the polled condition,—Anglo-Saxon "hamelian," to mutilate. The term "doddie," it is here suggested, may derive from a local place-name, for the Loch of Dodd is the old name for Rescobie Loch.

Silver Fox Farming. Mr J. M. D. Mackenzie, Sidlaw Fox Farm, Balbeggie, Perthshire, has kindly furnished the following information. There are a number of silver fox farms near Dundee and Perth, the dry cold climate of the East Coast suiting the animals and white hare and venison being readily available as food. Careful selection of the strain and good management have resulted in considerable success in show competitions. The silver fox is a melanistic mutant of the ordinary Canadian red fox, *Vulpes fulva*, the blackness being recessive to red. Little is known of the inheritance of fur characteristics, except that it seems to be possible that blackness and maleness, and paleness and femaleness, are linked. Husbandry has shown that the best diet must contain a certain amount of vegetable matter; and that the incidence of internal parasites (except the bladder worm) is diminished by rearing in pens provided with board floors instead of earthen.

Deer. Red deer (*Cervus elaphus*) are still plentiful on the mountain moors and are hunted for sport. In winter they come down for food into the valleys in scores and even hundreds, and are a pest to the farmer. The roe deer is rare but was common on the Sidlaws in 1813 (Harvie-Brown, 3). The red, fallow and roe deer were stated to be rare by Don in 1813.

Other Mammals. The present local status of many of the common wild mammals remains to be determined. Of marine forms the common seal is still common, principally on the sandbanks near Tayport, and whales occasionally appear (see page 49). Of carnivores the weasel, stoat and otter occur, while foxes can be so numerous in the glens as to be pests. The rodents, at least in the Carse area (Harvie-Brown, 3), comprise wood mouse; house mouse; brown rat; water vole, the black variety, common around Perth; field vole; bank vole. The squirrel was not mentioned by Don in 1813, but was first seen in the Carse in 1822, probably arriving from Dunkeld, though the Tay has been colonized from both Clyde and Forth. The rabbit, of course, is too plentiful. Don in 1813 noted it as rare, "hardly a native," but Edwards in 1678 stated that it was in plenty in many places and that "their warrens when well stocked, are let at a very high price." Brown hares are common in the lowlands. The mountain hare of the higher levels is so abundant as to be a pest, three hares, it is said, eating the equivalent of one sheep. In the shooting season, November to February, as many as a thousand may be shot at a big drive. Of the insectivores, moles and hedgehogs are common—but regarding shrews there is no information. Of the bats Harvie-Brown (3) in 1906 records the long-eared bat in the Carse, and the pipistrelle and Daubenton's bat as common around Perth. Bats occur elsewhere but the species are not recorded.

Birds.

The status of the Angus birds is yet to be worked out. Baxter and Rintoul (19) list about 393 species for Scotland, 114 being resident; the corresponding numbers for Angus are about 225 and 86. The subject is too detailed for treatment here, but the following deserve brief mention. The resident species are: coastal and aquatic—21 (see below); finches—12; birds of prey—8, peregrine falcon, merlin, kestrel, golden eagle, sparrow hawk, long-eared owl, tawny owl, barn owl; game birds—5, grouse, blackcock, pheasant, partridge, capercaillie; "crows"—7, raven, hooded crow, carrion crow, rook, jackdaw, magpie, jay; pigeons—3, rock dove, stock dove, wood pigeon.

The Estuarine Birds. The estuarine region of great ornithological interest extends from the mouth of the Earn to Buddon Ness, about 24 miles, the main bird haunts being the reed and mud flats near Invergowrie, the extensive sandbanks exposed at low tide, and, at the mouth, the moorland and sandhills of Barry on the north and Tentsmuir on the south.

Records have been made by Hay (20), J. B. Corr (4), and W. F. Alexander (21), the species numbering about 76, of which 22 are resident, 6 are regular summer migrants, 23 are regular winter migrants, 17 are occasional winter visitors, and 8 are rarities from the Arctic. The resident birds are 9 waders and 13 swimmers: the waders are heron, lapwing, golden plover, oyster catcher, curlew, redshank, dunlin, and common snipe; the swimmers are shelduck, wild duck, teal, eider duck — all fairly common, the eider nesting on Tentsmuir, razorbill, common guillemot, cormorant, great black-backed gull, lesser black-backed gull, herring gull, common gull, kittiwake, black-headed gull. The regular summer migrants are 1 wader, the sandpiper; and 5 swimmers, the common, Arctic, lesser, and Sandwich terns, and the gannet. All except the gannet nest on Tentsmuir, arrive in May, the nesting colonies of the terns in early June being a wonderful sight. The regular winter migrants are 6 waders and 17 swimmers: the waders are greenshank, water rail, spotted crake (shy, retiring and uncommon), godwit, knot, and jack snipe, most of which are found on the mud banks during autumn and winter; the swimmers are 5 kinds of geese—grey lag, bean, pink-footed, white-fronted and brent (the bean and white-fronted becoming rare), and 8 kinds of duck—pochard, tufted, widgeon, scaup, common scoter, velvet scoter, golden eye, and long-tailed, as well as goosander and red-breasted merganser, both of which breed on lochs of the Tay basin, and the red-throated and black-throated divers, the latter being rare. The occasional winter visitors are 5 waders and 12 swimmers: the former are the bittern—rare, whimbrel—a passing migrant only, sanderling, turnstone, great snipe; the swimmers are wild swan, Bewick's swan, shoveller, pintail duck, smew, great-crested grebe, horned grebe, black guillemot, puffin—in autumn and spring, fulmar petrel, storm petrel, shag. The still more casual visitors from the Arctic, alighting on their north-south line of migration and seeking food during severe winters, are king duck, little auk—which occasionally invades in numbers, glaucous gull, Iceland gull, the pomatorhine, Richardson's and Buffon's skuas, and great northern diver—almost to be considered a regular winter visitor.

Cliff Birds. Regarding mainly the Arbroath cliff birds, Dr. Dewar of Arbroath has kindly summarized for us the fruits of a life-time of keen bird-watching. The peregrine falcon has bred at Red Head for sixty years at least. The kestrel is still seen now and again, but was common till after the Great War. The raven used to breed at Red Head, circa 1852. The hooded crow formerly nested on the Arbroath cliffs where it seemed to be resident. The rock pipit is common all along the shore. The rock dove nests in caves in the cliffs between Arbroath and Red Head, often mixed with domesticated pigeons. The oyster catcher is common all along the shore in winter and has been found nesting on the shingle banks of the North Esk. The greater ringed plover, the curlew, the redshank, the dunlin, and the purple sandpiper haunt the sands in winter, and the Arctic(?) tern, lesser tern, black-headed gull, great black-headed gull, and herring gull are also seen. The puffin

nests in various caves between Auchmithie and Red Head. The razorbill is common in winter time. The common guillemot nests near Auchmithie. The fulmar petrel has increased steadily in numbers during the past twenty years and is thought to breed. The gannet and the cormorant have been observed, the latter roosting on the Scart Rock, near Red Head, though nests have not been detected.

The sex ratios of the Tay ducks have been studied by H. Boase (22), who finds, broadly speaking, three possible variations: equality is shown in the mallard; apparent surplus of females in the widgeon, scaup and goosander; and a varying surplus of males in the shoveller, pintail, pochard, tufted duck, goldeneye, long-tailed, eider, scoter, velvet scoter, merganser.

Capercaillie. This handsome bird is still found in Angus, though its present status is not known. Dr. Dewar informs us that it is not uncommon on Montreathmont Muir, where nests have been found by him; and as recently as 1894 a bag of 107 was obtained at Fotheringham (James Ritchie, 16). The present denizens of the county, however, are descended from introduced birds and are not of native stock, which, with the destruction of woodlands, disappeared in Scotland about 1770. Edward (1) speaks of their local occurrence in 1678. The successful re-introduction of the bird was largely due to the Marquis of Breadalbane, who obtained specimens from the continent and freed them at Taymouth Castle, Perthshire, whence they spread along the Grampian system and elsewhere, reaching Glamis in 1863 and Brechin in 1870. Their success was augmented by stock introduced in 1862 at Cortachy by the Earl of Airlie. Its hold will depend upon the maintenance of the woodlands.

Courtship and Nesting Habits. Interesting observations have been recorded by that excellent observer, Mr Henry Boase (23), for fulmar, goldeneye duck, great crested grebe, and by Colman and Boase (24) for red-breasted merganser; eider, teal, and tufted duck (25); pied wagtail (22) and mallard (26); and sheld-duck (27, 28).

Migration. The westerly flight of swallows, house martins, sand martins, swift, finches, pied wagtail, missel thrush and skylark has been discussed by Boase (22). From fourteen years' careful observations with Balgay Hill, Dundee, as the central locality, Boase (29) also deals with the local movements, or " drift " incident to the migration of summer visiting birds. The birds principally concerned were willow-warbler, spotted fly-catcher, tree-pipit, redstart, blue tit, great tit, coal tit, goldcrest, and tree-creeper. While the actual direction of the main movement over the passage line on which Balgay Hill must lie has not been determined, there is some indication that it is south-east. However, the period of the main movement for the departure of the summer visitors has been determined as August 5-12, though movement is well on the way by mid-July and is almost completed by the first week in September.

The Spring migration along the valleys of the Tay and the Earn was observed by J. Berry (30), the records relating to sand martin, house martin, swift, swallow, chaffinch, common bunting, fieldfare, common sandpiper, and willow, grasshopper, and sedge warblers, and, especially, geese and ducks.

That season on the Tay was very unusual as the weather conditions caused the birds to collect and move in great flocks, instead of allowing successively arriving smaller flocks to nest a short time and then hasten on.

The geese observed were pinkfoot, greylag, widgeon, bean, yellow-billed bean, and white-fronted, and Berry was greatly struck by the amazing numbers, especially of the pinkfoot and the greylag. The ducks were mallard, teal, widgeon, shelduck, and tufted—in large numbers, and goldeneye—in surprising numbers. Snipe, curlew, and redshank were also observed. The general line of geese migration from south to north was by Glenfarg, across the Tay near the mouth of the Earn, and north-eastward to cross the Sidlaws to the east of Dunsinane Hill. As for the duck the author (*in litt.*) considers it possible that they follow the coast northwards via Montrose and Aberdeen. The author also informs us that the pinkfooted and greylag geese seem to come from Iceland and the duck mostly from Scandinavia.

Fish.

Sea Fisheries. Interesting glimpses of local conditions early in the nineteenth century may be seen in Headrick (2). "In the sea are caught podlies (which seem to be the fry of the cole-fish), whitings, haddocks, cod, ling, and various others. It is only since stake-nets began to be erected in the Frith of Tay, that herrings were discovered in the frith, from some that were entangled in the nets. Since that discovery was made, considerable quantities of them have been occasionally caught in the Frith of Tay, during the winter season. But they are then very lean, and seem to be in the act, or about to deposit their spawn. Of late years, the herring-fishery has been tried in the open sea, . . . and considerable quantities taken in the months of June, July and August. Those earliest taken were plump and fat, and no way inferior to the best Lochfine herrings. . . . . Another discovery has been made by these stake-nets,—that garvies (sprats) and spirlings (smelts) abound in the Frith of Tay. . . ."

"Of flat fish, flounders of various kinds, soles, skates, thornbacks, and turbots abound in the seas; but as the fishers seem to be unacquainted with the use of trawl-nets, few are taken, except such as bite the bait used for cod or ling. Of the shell-fishes, there are several muscle beds, which are used for food when in season; but are generally used as bait for other fishes. The Dutch, who are dexterous fishers, always use eels, when they can be procured, as bait for cod and ling; and it would perhaps be advisable, that our sea-fishers should have recourse to the eels, which abound in some of our fresh-water streams, for these purposes."

"The sea near the Bell Rock, so long the terror of navigators, is said to abound with cod, ling, haddocks, and fish of all sorts; and this may be approached with safety now that a lighthouse is constructed upon it. The best fish are caught on banks, well-known to the fishermen, at a considerable distance from the coast. This business has been rather languid for some time past, because the young men are afraid of being impressed on board a man of war, should they venture out; and the old men are not able to go to a sufficient distance from the coast."

"Salmon fisheries have been carried out to a very great extent, on all eastern rivers and coasts of Scotland, ever since Mr Dempster of Dunichen suggested the plan of conveying fresh salmon to the capital of the empire, packed in ice. . . . Every salmon fishery of any note, on the east coast or rivers, is now provided with an ice-house, in which a sufficient stock of ice is stored during the winter, to serve during the ensuing fishing season."

" In the sea too they (salmon) grow rapidly, and soon get fat ; and their gills, backs, and sides become thickly studded with a small black animal named by the fishers, the sea louse ; whose attacks seem to inflict upon the poor salmon excruciating tortures, and force it to have recourse, for relief, to the fresh water. A few gulps of river water seem either to kill the sea louse, or to deaden the pain it inflicts."

Writing in 1912, the late Sir William High (4), from his personal business experience, deplored the fact that Dundee was not an important fishing centre despite its being the only suitable port between Aberdeen and Shields and within striking distance of grounds not fished by the drifters of Aberdeen on the north and those of Lowestoft and Yarmouth on the south. Success, he stressed, would depend upon dependable supplies of fish in large quantity, these, in turn, depending upon the operation of a large local fleet—from 40 to 50 trawlers for a start—a matter which would require a fair amount of capital.

For a recent review we are indebted to Dr. Henry Williamson, who writes as follows : " During the past fifty years a change has taken place in the fishery on the coast of Angus. Ports which once were active fishing centres have now abandoned fishing. This change has coincided with a decline in line-fishing, and the adoption of net-fishing. Montrose and Broughty Ferry, which are favourably situated in that they have adjacent beds of mussels, and sandy beaches where worm bait can be obtained, have now given up line-fishing and have reduced their operations to a very considerable extent. Arbroath, the only port where fishing, apart from steam-trawling, is carried on actively, has adopted the seine-net as the principal method of fishing for plaice or haddocks, while for herrings the ring-net is substituted for the drift-net. At Broughty Ferry, where at one time forty-five sailboats, measuring 15-60 feet on the keel, operated in St. Andrews Bay, Carnoustie Bay, on the Bell Rock ground and to the eastward of that region, there is to-day no fishing boat. These grounds provided plaice, dabs, haddocks, and cod, and lines were baited with lug, rigger, and mussel. At one time flat fish were also to be caught inside the estuary, but the fishing as a whole was carried on outside. Herrings are obtained here in autumn and winter, but in very uncertain quantities, their visits in large numbers being intermittent. Montrose used to be the most important fishing town in Angus. In addition to the line-fishing, a fleet of sailing drifters, many coming from other ports, assembled here for the summer herring fishing from July to September. Curing and kippering of the herrings was carried on. Two steam trawlers were also based in this port, at the time when beam trawling was taken over by steamers. Neither trawlers nor drifters work out of Montrose now. A few lines and seine boats are the sole survivors of a prosperous industry.

In the hey-day of the fishing on the coast of Angus, line fishing was the main industry. It was carried on during much of the year, and was interrupted for the herring season. Line fishing involves more labour than net fishing, and that possibly accounts in part at least for its abandonment. Crabs and lobsters are still fished for on the coast. Dundee is now the most important fishing centre ; several trawlers work steadily out of the port, but their catches are now smaller than formerly."

A further note on herring is given on page 47.

Salmon Fishing. The salmon stake nets are familiar sights at various points on the Angus coast, the sweep net, however, being used in the Tay. The historical, scientific, commercial, and legal aspects of the Tay salmon fishing have been excellently treated by Mr W. Malloch (31). The author recalls how at the end of the thirteenth century Edward I. overran Scotland, bringing with him trained fishermen, so that many a barrel of Tay salmon must have accompanied the Stone of Destiny to London. But centuries earlier salted salmon were trade goods for Bruges cloths, Bordeaux and Rhine wines, and other continental amenities of culture, dress and table. Salmon sent to Newcastle were there pickled in vinegar, becoming thereby "Newcastle Salmon." In the eighteenth century, Perth had its own fish curing establishments trading with London but, later, fresh fish reached that market by the use of ice packing and fast sailing smacks. For the size of the river the numbers of salmon caught in earlier times were astonishing. During the decade 1788-1797 the Kinfauns Fishings alone obtained 87,000 salmon and 17,070 grilse, while after 1797, when stake net fishing was revived, a single net over one season at Errol captured 7,000 fish. It is no wonder that the apprentices of earlier times stipulated that salmon should not be served them more than three times a week. The stake net fishing depleted the fisheries, but its prohibition in the estuary and river in 1814 brought about an immediate improvement, the Kinfauns Fishings between 1815-1824 returning over 90,000 salmon and nearly the same number of grilse, the gross rental of the river reaching £14,592. But the use of stake nets on the coast in 1820 led to hard times for the salmon tacksmen of the Tay, and the more rational exploitation of the fishery did not occur until after scientific investigation and legal action based on such.

Regarding the life history of the salmon, it was not until after 1853, from experiments initiated at Stormontfield, Perthshire, that parr were proved to be the young of salmon. This led to the passing of the Act of 1868 under which parr and smolts are fully protected. On the formation of the Tay Salmon Fisheries Company in 1899 this body conducted further scientific work, among the consequences of which was the earlier closing of the netting season, the curtailment of netting stations and an energetic campaign against predatory animals.

The migration of smolts of salmon and of sea trout were studied in the Tay in 1903 and 1904 by the Fishery Board of Scotland (32, 33). It was found that the smolts gathered in great numbers at a fixed rather restricted area in the tidal waters four miles below Perth. They then moved off, sea-trout first, with some abruptness to the sea. The sea-trout smolts could be taken on the ebb and flood tides below the Dundee-Tayport line, but the salmon smolts went out to sea on the ebb tide and made no temporary return to the flood.

In May and June, 1905, at Kinfauns, the Tay Salmon Fisheries Company began research on the life history and movements of the salmon by marking 500 smolts with a fine silver wire inserted in the dorsal fin, Mr P. D. Malloch, the Managing Director of the Company, originating and supervising the work. The results showed that salmon returned to the same river the year after and later, and that some could make a second return, after they had spawned once in the river and gone down to the sea as kelts. These results were correlated with and firmly established the science of scale reading from which,

by studying the rings and zones of scales, the age of the salmon can be determined and some idea also of the condition under which it has lived during growth.

With the view to elucidating the factor which caused the final departure of the smolts from their temporary gathering area to the sea, the Board arranged for a further research in 1931, with Mr J. Berry as observer (34). The results from marked fish show that the maximum intensity of sea trout migration occurred during May 4-9, that of the salmon smolt during the next week, May 11-16. At the higher assembling areas the arrival and departure are more gradual than at lower assembling areas where, also, a shorter halt is made. The chief factor governing the halts is suggested to be temperature, not current velocity; that governing descent is storm, though this is more noticeable in salmon.

Sprat and Sparling Fishing. The principal fishing now carried on in the estuary is for sprats (*Clupea sprattus*) and sparlings (*Osmerus eperlanus*), six boats operating from Dundee and two from Newburgh, between September and March. The boom net, introduced from England, is used. This fishing has declined (Newburgh once had 34 boats) for the sprats are uncertain in their appearance and quantity, and prices, too, are uncertain. Sprats preponderate in the nets from October to December, but in January the young herring predominate (Malloch, 35). The sparling can be more or less abundant from April to June, being most plentiful at the beginning of May, the April catches being mostly kelts in poor condition, though many may be still distended with spawn. Fry may be found in huge numbers at the end of April (Berry, 34).

Other Fish. The following records are given by Berry (34) for the period April-June, 1931. The trout was found as "Whitling" and as "Yellow Trout." The stickleback (*Gastrosteus aculeatus*) was taken regularly, the common fresh-water and laterally-keeled estuarine forms being about equal in number. The lampern (*Petromyzon fluviatilis*), occurring at the end of April and the beginning of May, were of two distinct types: the larger kind, 9-12 inches; and the smaller and darker kind, 4-5 inches, possibly the doubtfully distinct species the pride (*P. planeri*). Both Alexander (21) and Berry (34) note the following: the viviparous blenny (*Zoarces viviparus*); the eel (*Anguilla vulgaris*)—noted by Berry as small and brown, about a foot, or sometimes larger and grey, few elvers being taken in April and May; the flounder (*Pleuronectes flesus*)—according to Berry the most abundant of all fish, several hundred sometimes being netted in an hour. Alexander also records the plaice (*Pleuronectes platessa*), the gunnel (*Pholis gunnellus*), the goby (*Gobius pictus*), the angler (*Lophius piscatorius*), and a bull-head (*Cottus scorpius*).

From intimate knowledge Mr J. Cameron informs us that the fishes of the Isla are: marine lamprey (*Petromyzon marinus*); river lamprey (*P. fluviatilis*); salmon (*Salmo salar*); sea trout (*S. trutta*); brown trout (*S. fario*); grayling (*S. thymallus*); pike (*Esox lucius*); perch (*Perca fluviatilis*); three-spined stickleback (*Gastrosteus aculeatus*); loach (*Nemachilus barbatulus*); minnow (*Leuciscus phoxinus*); eel (*Anguilla vulgaris*). The fish restricted to the lower Isla (Den of Airlie to Islamouth) are the migratory marine lamprey, salmon, sea trout and eel. All these fish are indigenous, except the grayling, which is a naturalised species.

Mollusca.

The authority on the local molluscs, the late Mr H. Coates (36), concluded that Perthshire is very rich in mollusca. Of the 121 species recorded for Scotland 93 are found in Perthshire, 58 of these pertaining to the Carse of Gowrie. Of the last, 5 are by no means common in Scotland : *Hyalinia radiatula, Helix aspersa, Vertigo antivertigo, V. pygmaea* var. *pallida, and Limnaea palustris* var. *elongata* ; and 4 are Scottish rarities, viz., *Ashfordia granulata, Hygromia striolata, Sphyradium minutissimum*, and *Limnaea glabra.* The small snail, *Hydrobia jenkinsi*, a recent invader from the sea of the brackish waters of Great Britain and the Continent, is one of the two molluscs—the other is American—which lacks males or male organs and reproduces by virgin birth, that is, is parthenogenetic. Dr. Ann R. Sanderson, who has studied the species cytologically, informs us that the Huntly Burn specimens are the non-keeled forms characteristic of less brackish water. Coates (36) and Alexander (21) do not mention the type they collected.

The pearl mussel (*Unio margaritifera*) is found in the South Esk, in the Tay above Perth, and probably in other Angus rivers. The Tay was the principal seat of British pearl fishing, its value between 1761-1764 being £10,000. To-day, owing to over-fishing, the fishing is of little value (Coates, 37). For other records of fresh-water molluscs see page 46 and Scott (47, 48).

Insects.

From previous records and from recent work principally relating to the Clova district, a considerable amount of information on several insect orders has been compiled in the Natural History Department, University College, Dundee. It is not yet in form for general publication, but is, however, available for specialists. In this article, therefore, attention is confined to a few special studies on insect ecology and insect pests.

The Insect Fauna of the Higher Altitudes has been treated by J. C. Willis and I. H. Burkill in their important paper " Notes on the Anthophilous Insect Fauna of the Clova Mountains " (38, 39).

Over the period 1894-1899, during the spring, summer, and autumn, these workers made 17,306 observations on individual insect visits to flowers, principally by hymenoptera, lepidoptera, diptera and coleoptera. Many of their conclusions are too technical for inclusion here, and mention can be made of a few features only.

The highest percentage of visitors, 66.76, was obtained by the short-tongued diptera, the other groups showing small percentages in the following descending order : coleoptera, 7.47 ; mid-tongued diptera, 6.58 ; *Bombus* and *Psithyrus*, 5.41 ; Apis, 2.47 ; long-tongued lepidoptera, 2.29.

The authors distinguish five zones in ascending order—strath, second belt, third belt, crag belt (2,000-2,500 feet), high moors, and also deal with the altitudinal distribution of the hymenoptera. The strath forms, chiefly humble-bees, are the early humble-bee, *Bombus pratorum* L., mostly found in the strath ; two carder-bees, *B. agrorum* F. and *B. venustus* Smith, the latter rarely leaving the strath ; the small garden humble-bee, *B. hortorum* L., and buff-tailed humble-bee, *B. terrestris* L., both most abundant in the strath, but also found at the high levels ; also the mid-tongued hymenoptera such as Odynerus and the wasps, low level forms ; and sawflies such as *Allantus*

arcuatus. The third belt Bombus is the bilberry humble-bee, *B. lapponicus* F., more common above 1,000 feet than below; it is the chief Bombus to visit the Alpine flowers. At all heights is found a cuckoo bee, *Psithyrus quadricolor* Lep. Also mentioned are *B. Scrimschiranus* and *B. ionellus*.

The flower-visiting lepidoptera are greatest in variety in summer, while the autumn maximum is due to a few species present in large numbers. The spring long-tongued lepidoptera are chiefly the butterflies, the small tortoise-shell (*Vanessa urticae* L.), and the green-veined white (*Pieris napi* L.). The chief summer species is the common blue (*Lycaena icarus* L.), but there also occur, among others, the dark green fritillary (*Argynnis aglaia* L.), the small pearl-bordered fritillary (*A. selene* Schiff.), the small heath (*Caenonympha pamphilis* L.), several species of Plusia and *Eriocephala calthella* L. The autumnal moths were mainly the ear moth (*Hydroacia nictitans*), Haworth's minor (*Celaena Haworthii*, Curts.), while the somewhat autumnal small copper butterfly (*Polyommatus phloeas* L.) also occurred.

The flower-visiting coleoptera showed an increase to autumn. In spring they are rare; in summer there are many species, *Meligethes viridescens* F. and *M. aeneus* F. being the commonest, followed by *Epuraea aestiva* L., with *Anthophagus alpinus* Payk. quite common; the autumn abundance was due to the two species of Meligethes.

The notable Alpine insects are few, namely: Hymenoptera — the bilberry humble-bee, *B. lapponicus*; Lepidoptera—the small ringlet, *Erebia epiphron* Kn.; the black mountain moth, *Psodos trepidaria* Tr.; the crambid moth, *Pyrausta alpinalis* Schiff.; Diptera—two species of " bird's beak flies " (*Empis vernalis* Mg. and *E. lucida* Ztt.); a " blossom fly " (*Limophora solitaria* Ztt., Anthomyidae); a " daddy-long-legs " (*Tipula excisa* Schum.); Coleoptera—a " blossom beetle " (*Anthophagus alpinus* Payk.).

Some interesting observations are made on many species of hover flies and their reactions to flower colour. For instance, *Chilosia fraterna* was always taken on flowers of bright yellow colour, whilst *C. sparsa*, *C. antiqua*, *C. bergenstammi*, and *C. scutellata* were observed principally on yellow flowers, *Chrysogaster hirtella* probably showing a similar preference. But *Rhingia campestris*, which visited eleven species of flowers, chose those with more or less blue in them, and no other syrphid showed such a favouritism for this end of the spectrum; *Sericomyia borealis* visited the lilac-blue *Scabiosa succisa* freely, but no other flower of that hue; *Eristalis rupium* and *E. arbustorum* seemed to avoid the extreme of blue. The small syrphids tended seemingly to prefer white and yellow flowers, though *Platychirus manicatus* visited flowers of lilac-blue, rose-purple, white, and yellow with almost equal partiality.

Aquatic Coleoptera. The major part of our knowledge of the local beetles concerns aquatic forms, studied by F. Balfour-Browne (40). Altogether 84 species are listed for Angus, the genera showing the most species (number given in brackets) being Hydroporus (20), Agabus (11), and Haliplus (8). Several distributional notes are of interest: *Hyphydrus ovatus* L. has not hitherto been recorded north of Midlothian; *Deronectes griseo-striatus* De G. occurs almost entirely in small highland lochs and large peat holes from 800 feet upwards and is restricted to Scotland and Ireland (with the possible exception of Cumberland); *Hydroporus lineatus* F. was not found elsewhere than in one small loch, where it apparently reaches its northern limit;

Agabus affinis Payk. is known in only 14 of the 40 Scottish counties and vice-counties, from Eastern Inverness southwards; *Agabus congener* Payk. is a typical mountain species of wide distribution; *Ilybius subaeneus* Er. has not been recorded elsewhere in Scotland, and in view of its restricted distribution in England the author raises the question as to whether the species has declined in the south and has recently become established in Scotland; *Acilius fasciatus* De G., common at Restenneth, but not found more north, is now a northern and mainly Scottish species and is possibly another case of an insect which has declined in England and colonized Scotland; *Octhebius lejolisii* Rey and Muls provided a new record for the east coast of Britain. The forms of *Deronectes depressus* F. and *D. elegans* Panz. show a fairly complete range from extreme *depressus* to extreme *elegans*, but the data do not allow a decision as to whether they are separate species which hybridize or are a single variable species.

Insect Pests. Despite its reputation as a fertile area for farm and fruit crops Angus has been little studied from the point of view of its agricultural pests. The wheat bulb fly (*Leptohyleomyia coarctata* Fall.) was investigated by Gemmill (41) at various points around Dundee and among the many important points noted were that couch grass (*Agropyrum repens*) appeared to be the natural host-plant of the pest; and that the areas in which the fly was most abundant were those in which most wheat is grown following potatoes (especially early potatoes), and in general the fields worst infected in any one year were those in which the previous year's root crop or fallow was close to infected wheat fields. Among a number of preventive and remedial measures suggested was that of avoiding the sowing of wheat after potatoes or other root crops of fallow. By this the author believed that the numbers of the fly would be so reduced that the pest would cease to be a menace for many years to come, during which the customary rotation could be followed.

Work on raspberry pests has but recently been begun locally. During the season 1938 Mr F. L. Waterhouse and Miss A. Adam, University College, Dundee, studied the conditions existing in a Longforgan raspberry farm and discovered the presence of the two well-known pests, the raspberry beetle (*Byturus tomentosus*) and the raspberry moth (*Lampronia rubiella*). It would appear that both insects are probably more serious pests than commonly supposed locally.

Malaria fever (ague) was once common in the Carse of Gowrie and Angus, as in other places of Scotland (James Ritchie, 16), and although not known to-day it is probable that the insect vectors of this disease, mosquitoes of the genus Anopheles, still exist in the Carse, for W. Keir (42) has obtained *Anopheles bifurcatus* from Downfield, Dundee. The late Professor J. H. Ashworth (43) records a possible case of indigenous malaria at Kirriemuir just after the Great War, the organism being possibly derived from soldiers affected abroad.

Lepidoptera. Very little local work has been done in this group and the status of such species as are recorded is not worked out. A list of 55 species of Noctuae, captured in 1893 near Montrose, is given by Gunning (44), and a second list (45) of 123 butterflies (a few) and moths taken in 1895 near Montrose—on the coast, on sandhills, on heather, sallow and ragwort, and by sugaring. Certain of his 1895 collection (45) were unusual local appearances, namely, the brindled green (*Hadena protea*), merveille du jour (*Dichonia*

aprilina), and the cinnabar (*Euchelia jacobaeae*), which, however, we know to be common at Monifieth and Tentsmuir. Variations from this type were also remarked in certain noctuids, namely, the Hebrew character (*Taeniocampa gothica*), the autumnal rustic (*Noctua glareosa*), the clouded bordered brindle (*Xylophasia rurea*), the marbled coronet (*Dianthoecia conspersa*), and the green brindled crescent (*Miselia oxyacanthae*).

Observations on the coloration of local specimens of light sensitive caterpillars have been made in Glen Clova and Glen Doll by Harrison (46). Certain larvae of the November moth (*Oporinia autumnata*) taken from birch were yellow green instead of bright apple green. The larvae of the December moth (*Poecilocampa populi*) obtained from *Salix aurita*, a pale habitat, were very light in colour, whereas those found on alder, both in the glen and elsewhere, were dark. The larvae of the scalloped oak (*Crocallis elinguaria*) found on a very unusual food-plant, red currant, also showed adaptive coloration.

Alpine forms are the small mountain ringlet (*Erebia epiphron* Kn.), the black mountain moth (*Psodos trepidaria* Tr.), and the crambid *Pyrausta alpinalis* Schiff., noted by Willis and Burkill (38).

Crustacea.

Little is known of local crustacea except the records in " The Invertebrate Fauna of the Inland Waters of Scotland " by Scott (47, 48). In the first paper the crustacean and molluscan faunas of Loch Rescobie and the connected Loch Balgavies are briefly dealt with and the number of crustacean species for each loch was practically the same, being, respectively : Amphipoda, 1,1 ; Copepoda, 15,12 ; Ostracoda, 12,10 ; and Cladocera, 16,17, though the numbers of mollusca were markedly different, Rescobie having 11 and Balgavies 3, a result which may be accidental. A copepod new to science, *Canthocamptus inornatus*, another new to Great Britain, *Cyclops varicans* G. O. Sars, and a rare ostracod, *Darwinula Stevensoni*, were discovered in both lochs. The second paper deals with Forfar Loch, the species being : Amphipoda, 1 ; Copepoda, 18 ; Ostracoda, 18 ; Cladocera, 13 ; Mollusca, 14, including *Anodonta cygnea* found in the burn outflow. Specially interesting are the occurrence of the copepods *Canthocamptus inornatus* (mentioned above), and *Moraria brevipes*, rare in Scottish lochs ; of the ostracods *Cypris pubera* and *Ilyodromus violacea*, rare to Britain ; and of the somewhat rare *Leydigia quadrangularis*, observed only in a few Scottish localities.

Platyhelminthes.

Several new local larval trematode worms and larval tapeworms parasitic in fresh water and land invertebrates have been investigated by W. F. Harper (49-53), and some have been related to the adult forms by infecting ducklings. The host animals include water and land snails, larvae of alder flies, caddis flies, diptera, ostracods, an amphipod, a land oligochaete, and a turbellarian.

Rotifera.

About 100 species of local rotifera are recorded for the Tay in Hudson and Gosse's monograph (54), which describes about 400 British and foreign species. These local records were primarily due to Hood (see page 31). We possess

Hood's copy of this monograph and it is of particular interest because many of its annotations and sketches are by Hood himself. He gives a list of 65 new species discovered by him, some of which bear the name *hoodi* ; another list of 19 species, the males of which he was the first to find ; a third list of 36 species from the domestic water supply ; and another of 35 marine forms collected from the Tay, only 8 marine forms having been previously recorded. In addition, he lists 62 species of infusoria from Dundee Harbour and 12 hydroids from the river and harbour. The monograph repeatedly reflects the authors' high estimation of Hood, and one of Hood's own annotations also illustrates this. He comments that, although the species *Oecistes mucicola* and *Oe. socialis* were first described respectively in America and in Geneva, he had sent these, believing them to be new, some years previously to Hudson, who, however, considered them to be *Oe. crystallinus*. When these foreign authors had published their description, Hood again drew Hudson's attention to the matter, but the upshot, in Hood's own words, was " His reply oh never mind a new Rotifer is not a pet lamb to you now."

Rare and Unusual Records.

Mollusca. Interesting records of cephalopods exist for Angus. The octopus, *Octopus vulgaris* Lam., was found on the beach at Montrose in 1893. The giant squid, *Architeuthis harveyi* Verrill, has also been obtained. A trawler fishing off the Bell Rock near Arbroath captured a living specimen on 7th January, 1937, but in the struggle of handling it all that was secured were the two long arms, 15 feet 2 inches and 17 feet 6 inches long, and one of the short ones, 3 feet 9 inches. The body length must have been about 7 feet. Large numbers of the squid, *Todarodes sagittatus*, Lam., were cast up along the banks of the Tay estuary, and at various localities between Montrose and Dunbar, in February, 1937. The body length of the specimens reached 21 inches. The species occurs in the open waters around Britain and rarely a winter passes without an occasional stranded specimen being seen, but the reasons for the mass invasion and strandings of this particular year are unknown. The suggestion that they came ashore for spawning is negatived by the fact that the many specimens examined were immature. All these are referred to by Stephen (55).

Amphioxus. A specimen of the lancelet, *Branchiostoma lanceolatum* Pallas, was picked up on the beach at Montrose some few years before 1937. This is only the third record for the east coast of Britain, the other localities concerned being Norfolk and the Moray Firth. As the Montrose ground has sandy gravel or shell gravel, it is possible that further search will bring other specimens to light (Stephen, 55).

Fishes. Of rarities there are the belted bonito, *Pelamys sarda*, Cuv., taken at Montrose (see Day, 56), and the bass, *Labrax lupus*, Cuv., obtained off the Bell Rock in 1909, a first Scottish record (Thompson, 57). A recent interesting occurrence was the stranding of the curious oar-fish or King of the Herrings, *Regalecus glesne*, Ascan., at Westhaven in April 1938. It was a female, 17 feet 10 inches long, probably a record length for the occasional specimens found stranded in the British Isles (Peacock, 58).

A recent invasion of herring shoals to the Tay is of unusual interest. Formerly the estuary provided good herring fishing, but for nearly thirty years past the quantity of herrings has declined almost to vanishing point.

Then, in February, 1936, a remarkable influx of the fish occurred and provided drift net fishing for a few Broughty Ferry row-boats, as well as seine net fishing for a number of visiting motor-boats. Investigations were made by the Natural History Department, University College, Dundee, and Miss C. F. Drysdale reports (unpublished work) that the bulk of the catch belonged to the two-year class, the fish averaging 6.7 inches, though there occurred 4-5 inch specimens of the one-year class, and others up to the five-year class, of which the longest was about 10 inches. Only a few, the largest, were mature. The fundamental hydrographical and other causes involved, despite enquiry, are unknown, though it is possible that the shoals were actually making for the Forth.

The Musk-Rat Menace. The story of the musk-rat (*Fiber zibethicus*) in Scotland is that of a promising, if risky, scheme gone wrong. By its introduction the local waterways might have been populated by an undesirable alien which would certainly have produced far-reaching effects on the local "balance of nature." Fortunately, as it happened, the few local isolated invaders were killed (Munro, 59; *Glasgow Herald*, Dec. 27, 1932; *Dundee Courier and Advertiser*, March 23, 1934; *Daily Herald*, May 14, 1935). In 1927 six pairs of musk-rats were brought from Canada as the nucleus of a fur farm at Feddal, near Braco, Perthshire. Most of them escaped by biting through the wire netting of their enclosure and spread to give rise to numerous progeny which established themselves in Perthshire and Fife. The animals are elusive, live in deep burrows and in winter lodges, are healthy and prolific, and the damage they do to river and canal banks on the Continent is so enormous that a constant warfare is waged against them. The threat to our countryside was met by official action in 1932 and the campaign against them was led by Mr Munro of the Department of Agriculture for Scotland, assisted by Herr Roith, a Bavarian trapper expert. Up to September, 1934, the number of musk-rats trapped in the basins of the Forth and Earn was 945, in Scotland generally 1,085, all the seven years' progeny of five females and four males. In addition to records from the Earn, there are those of seven local single spies. One, not officially identified, was killed on June 13, 1931, near Dryburgh Farm, Dundee-Coupar Angus road. Another, now in the possession of the Dundee Sanitary Authority, was killed on March 13, 1933, on the same road. A third was shot by Mr William Berry on April 26, 1933, in his grounds at Tayfield, Newport, Fife, its length being 22 inches, and its weight 21 lbs. 5 oz. (data by kindness of Mr Berry). On July 18, 1933, another specimen was trapped near Tentsmuir, and on May 23, 1934, a kill was made at Glamis. The latter must have left the Earn for the Tay, journeyed up to the Isla, and from thence to Dean Water at Glamis. Another, 23 inches long, was killed by a dog on May 23, 1935, near Dairsie, River Eden. The last record relates to a specimen, 23 inches long, taken on June 17, 1935, at Broughty Ferry.

Aquatic Mammals. The common seal (*Phoca vitulina*) is a permanent resident on the sandbanks at the mouth of the Tay estuary and still penetrates as far as the sandbanks above the Tay Bridge, and even to Perth. Doubtless the warfare waged against it in the interests of the salmon fishing has greatly discouraged its venturing far from the safety of the more remote Tayport sandbanks. A stray harp seal (*Phoca groenlandica*) is recorded for Invergowrie Bay, September, 1895 (Harvie-Brown, 3).

Of whales, the common porpoise (*Phocaena communis*) has been found in large shoals as far as Errol, and a school of small pilot whales (*Globicephalus melas*), the largest not less than 22 feet long, appeared in the Tay on October 6, 1817, twenty to thirty of them being killed (Harvie-Brown, 3). The common dolphin (*Delphinus delphis*) apparently does not often frequent the North Sea, but individuals occasionally straggle into local waters. Two specimens were obtained between Buddon Ness and Monifieth in February, 1937, and yet another was examined in the same month and year at Arbroath by Professor Peacock. Their occurrence was very probably due to their following cuttle-fish which had invaded the North Sea (see p. 47 ; also Fraser, 60). Of other records there are white-beaked dolphin (*Lagenorhynchus albirostris*), stranded at Whiting Ness (Stephen, 61) ; bottle-nosed whale (*Hyperoodon rostratus*), once at Carnoustie, 1916 (Harmer, 62), and once near Tayport (Greenshields, 63) ; finner whale (*Balaenoptera physalus*) from the Bell Rock, Arbroath, 1918 (Harmer, 64) ; and four specimens of the lesser rorqual (*Balaenoptera acutirostrata*), stranded at Buddon Ness between 1913 and 1922 (Stephen, 65).

The most important occurrence was the great stranding in November, 1935 of 41 false killers (*Pseudorca crassidens* Owen), at Buddon Ness, Angus, and of 7 at Kinkell, Fifeshire (Peacock, Comrie and Greenshields, 66). There were 27 females (each of two with a foetus) and 21 males, and there appeared to be three size-groups for each sex ; among the females the size-group comprising the greatest number ranged from 14 feet to 15 feet 6 inches, the other two size-groups being between 12 to 13 feet and about 9 feet ; among the males the size-group comprising the greatest number ranged from 15 to over 19 feet, the other two being between 12 to 14 feet and between 9 and 11 feet. The males are evidently the larger. The ages of the representatives of these groups were then estimated to be, respectively, three years plus, two years and one year. Later investigations on the corpora lutea (Comrie and Adam, 67) allow the tentative suggestions that the age-range of four of the largest females was 3 to 4 years as a minimum and 12 to 20 as a maximum, with a mean of 7½ to 12 years, while two others were possibly twice as old. There are indications that the species sheds a single egg at each of a number of periods in the year, the winter months excepted. The dental formula for both sexes was characteristically 8/9 for upper and lower jaws respectively, though the numbers varied from 6 to 11.

Following this event, Fraser (68) gave an interesting account of the species. The false killer is a typical oceanic dolphin and its strandings, some of them of a wholesale nature, are recorded for various parts of the world. The winter strandings of 1935 on the east coast of Britain, of which that of the Tay was only one, mark the third appearance of the whale to Great Britain, the previous ones being at Dornoch Firth in October, 1927, and at Glamorgan in May, 1934. A satisfactory explanation of the 1935 strandings is not yet forthcoming, but as the circumstances render remote the possibility that they were due to migrations associated with reproduction, Fraser suggests that they resulted from the whales pursuing their fish and cuttle-fish food into unusual regions which proved to be dangerous by reason of shoal waters. That a change had possibly occurred in the distribution of the whales' food supply is borne out by the fact that since 1930 there had been an increasing strength of Atlantic flow into the North Sea.

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BRITISH ASSOCIATION

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A SCIENTIFIC SURVEY OF

DUNDEE AND DISTRICT

PREPARED FOR
THE DUNDEE MEETING 1939

BY VARIOUS AUTHORS

Edited by
R. L. MACKIE, M.A., B.Litt.
Training College, Dundee

These surveys, since their initiation in 1932, have been issued to members attending the Meetings, and have subsequently been included in the Annual Reports. The intention in future is to include the survey for the forthcoming meeting in the July issue of 'The Advancement of Science' preceding such meeting; whether that scheme will be possible in 1940, however, cannot be forecast. Meanwhile the Dundee Survey is continued here from No. 1 of 'The Advancement of Science,' and will be concluded in No. 3.

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VI.

AGRICULTURE IN THE DUNDEE DISTRICT

BY

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THE Dundee District, which may be taken to embrace the greater part of Angus, the north and east of Fife, and east Perthshire, includes lowland, upland, and mountain districts, and its systems of farming are largely determined by the elevation.

In the low country there is a large proportion of good or excellent agricultural land, and the general standard of farming is high. The soils vary, but are mainly friable reddish loams, of good depth, which suit a wide variety of crops. Few fields are too heavy for potatoes or swedes, and few are too light, given generous manuring, to yield satisfactory crops of wheat. The whole area having been glaciated, there are no marked differences between the soils overlying the Old Red Sandstone, the Carboniferous Limestone Series (which occurs in East Fife), and the volcanic rocks which run in a series of belts from south-west to north-east through all three counties.

Three exceptional soil types must be distinguished from the general run of medium loams. Here and there, in the valleys, are considerable areas overlaid by hillocky masses of morain sands and gravels, which give rise to light burning soils of little value. Examples are to be seen along the railway between Cupar and Dundee, round Gleneagles, and scattered along Strathmore. Secondly, there are areas of coastal sand-dunes, the largest being those on both sides of the lower Tay Estuary—Barry Links on the north and Tents Moor on the south. Most of this land is willingly resigned by the farmer to the golfer and the forester. In places the sand has been blown inland for some distance and has covered what was originally good soil. In the early part of the seventeenth century numbers of fields above Carnoustie were so deeply smothered that they passed out of cultivation for more than fifty years,* and have never since fully regained their fertility.

The third and most important exception is constituted by the Carse of Gowrie, a belt of rich, heavy alluvium lying along the north bank of the upper Tay Estuary and comprising nearly forty square miles. The land on both sides of the Earn, below Bridge of Earn, is similar. Some islands of loam stand up above the old river level, but the carse-land proper is a strong clay, too heavy for the satisfactory cultivation of roots or potatoes, but yielding very heavy crops of wheat, beans, and hay. Until the present century the Carse was largely arable, farmed under wheat, beans, hay, oats, and bare fallow ; but in recent years a good deal has been laid away to grass, the better pastures being used for cattle fattening. As root-growing is hardly

*Edwards' *County of Angus*, 1678.

possible, a good many of the farms have been equipped with tower silos, the crop used for ensilage being a mixture of beans, oats, and vetches. The Carse had at one time a reputation for its apples, and some old orchards still remain, though they are of little value.

Where there are steep escarpments, such as the Braes of the Carse and those of north Fife, the soils are, naturally, thin and rocky. On the leveller reaches of upland we get mainly " moorish " land, often lying on a boulder-clay subsoil which makes for difficult drainage and late spring growth. Where the drainage is completely impeded there are peat-bogs which, up till the nineteenth century, were the main sources of fuel for rural people. Many have been drained and reclaimed, but most have made only moderate farm land. Above the seven- or eight-hundred-feet contour are considerable areas of unreclaimed heather moor, used as sheep grazing. The largest is on the Sidlaws, which rise to nearly 1,500 feet.

North-west of Strathmore, as soon as we cross the Highland Fault, we reach typical Highland country, with narrowing belts of improved and enclosed land stretching up the glens, and wide expanses of heather-clad mountains between. The smaller farmers of the lower glens are chiefly cattle-breeders, while the large mountain grazings are given over to Blackface sheep.

The rainfall of the low country is generally under rather than over thirty inches, and the summer temperatures allow of the ripening of the majority of the common British crops. Winter wheat matures well up to an elevation of four or five hundred feet, and goes higher where the exposure is favourable. In many seasons some sowing of oats (of the variety " Marvellous ") is to be seen in Fife as early as January or February, and the main spring sowing of cereals can generally be begun, in the lower districts, soon after mid-March ; corn is commonly ripe by the third week of August. High yields of barley can be produced, but the malting quality does not compare favourably with that of samples grown in East Anglia, or even in East Lothian. The best local samples come from the coastal districts of Fife. Oats flourish on all but the lightest soils ; yields are probably as high as can be found in any part of the world, and the quality of the grain, in years of good harvest weather, is excellent. Mangels can be grown, but swedes and turnips give heavier yields. There is a beet-sugar factory at Cupar, and fields of beet are to be seen up to elevations of four or five hundred feet. The yield of sugar varies a good deal with variations in the season, the amount of sunshine being the most important factor. The average yield of washed roots may be eight or nine tons per acre. The cool climate is admirably suited to the production of healthy stocks of seed potatoes, and the potato is easily the most important cash crop.

A good deal of the past history of the countryside can be deduced from the lay-out of the fields and from the place-names. In the more fertile parts of the low country the great majority of the farm names are Gaelic, the commonest prefixes being Bal- (*Baile*=a farm town or hamlet), Pit- (*Pett*=a portion of land) and Ach- (*Achadh*=a field). Such names, except perhaps in the vicinity of the Highland Line, indicate farming settlement earlier than the thirteenth century. In many cases the modern farm descends directly from the original run-rig township, while in others the addition of a Scots or English word tells of a division of the old unit into separate farms ; local examples are Milton of Craigie, East Pitkerro, New Downie, Newton of Affleck, East Mains of Balmuir, etc.

The organisation of the local townships, some of which survived until the eighteenth century, was much the same as in other parts of Scotland, and is well illustrated in the *Rental of the Monastery of St. Marie of Cupar* (Coupar Angus). Thus in 1542 Coupar Grange, which is now a single large farm, was let to twelve tenants, each of whom had an equal share and paid, in annual rent, 26/8 Scots in money, 15 bolls 1 peck of barley, 3 bolls of oats, and 12 capons; provided the carriage of seven score and sixteen loads of peat and supplied twelve trusses of fodder (probably oat straw), with "common careage when they are chargit."

By contrast with the ancient farms of the fertile districts, the uplands generally show all the signs of recent reclamation and settlement. The farm names are such forms as Denside, Whitehouse, Bankhead, etc., the fields are rectangular, and there is other evidence of careful planning. In fact, most of higher land was still heather moor and bog until far on in the eighteenth century, and was reclaimed, for the most part, between 1760 and 1860. The work of reclamation involved the clearing of boulders, which in some parts were very numerous; drainage, which was done up till about 1845 by built stone drains and later by tiles; and, above all, the application of large quantities of lime. The lime required in the coastal districts was brought from Fife by sea, and some inland districts were supplied from local kilns; where limestone was inaccessible, the farmer fell back on deposits of shell marl, which occur in many of the lochs, and also under layers of peat on the sites of old lakes. Forfar Loch yielded large supplies of this material, and was successfully exploited by the Earl of Strathmore from about 1760 onwards. The water level of the loch was lowered by cutting a deep ditch, so that a good deal of the marl was laid dry, and the ditch was provided with a system of locks so that the marl could be taken by boat to the Earl's estate at Glamis.*

A further step of improvement was the extensive application of bones during the early part of the nineteenth century.

Concurrently with these reclamations of moor, and with the enclosure of the old township farms, were many other steps of improvement. Potatoes came into cultivation, as a field crop, after 1760, and the acreage has slowly but almost continuously expanded ever since. Turnips began to be generally grown about 1780, and there were considerable acreages of swedes by the beginning of last century. The sowing of leys, with mixtures of ryegrass, red and white clover, trefoil, etc., began about 1750, and the old tumble-down pastures of the outfields had disappeared by about 1780. Concurrently there were well-sustained efforts to improve the cattle, which provided the farmers of the time with the greater part of their cash incomes. The earliest improvers, about 1770, introduced Bakewell's Longhorn, but the results were not very satisfactory; in the end the farmers divided their patronage between the Shorthorn (which was first brought north by Barclay of Urie, in Kincardineshire, about 1825) and the Aberdeen Angus. The founder of the latter breed was Hugh Watson of Keillor, near Coupar Angus, who assembled his herd in 1810. Numerous pedigree herds of both breeds are still maintained in the district, and Perth has become the most important pedigree-sale centre, in the whole of Britain, both for the Aberdeen Angus and for the Scotch type of Shorthorn.

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*For a full account see Wight, *Present State of Husbandry in Scotland*, Vol. I. p. 274, 1778.

The impetus to cattle improvement was the improvement of communications, and the rearing and fattening of high-quality, early-maturing breeds were made possible by the use of bone manures for the improvement of the temporary pastures and for the production of heavy crops of swedes and turnips. Up till the early part of the nineteenth century the cattle for the English market were sold, as three- or four-year-old stores, at customary fairs (of which the largest was Trinity Fair near Brechin), and were taken south by drove-roads, many going as far as Norfolk to be fattened. Some fat as well as many lean cattle were shipped from Dundee and other ports in sailing coasters, but the voyage was often protracted, and the cattle suffered a good deal in stormy weather. The steamboats which began to ply in the early 'forties, and the railways which followed soon after, made it possible to send either fat cattle or sides of beef to London.

The generation which farmed from 1840 till 1880 reaped a rich reward for the labour and capital that their fathers had sunk in the land. In the 'sixties good low-ground farms were being let at figures like £3 and £4 per acre, but the prevailing custom of nineteen-year leases made for a long lag in rents, and tenants mostly throve. Serious depression did not come till the 'nineties.

The introduction of large-scale sheep farming to the Eastern Grampians began in the latter part of the eighteenth century. It was long considered that the winter climate was too severe for sheep, and the early system was to graze wethers on the mountains in summer and to take them to low ground for wintering. It was only after the middle of last century that breeding flocks were established. There are now some excellent flocks of a large and robust type of Blackface, and numbers of breeding rams are sold to other districts.

The most interesting of recent developments in the local agriculture has been the rapid increase in the area devoted to raspberry cultivation. In 1892 the total area of small fruit in the three counties was under a thousand acres. By 1912 this had increased to about 4,000, and by 1936 to 6,500. Of this last total nearly 5,600 acres were under raspberries. The chief areas of cultivation are round Blairgowrie (which was the earliest), Forfar, and Auchterarder, and the newest lies between Montrose and Brechin. The climate of the district seems to be almost perfectly suited to the crop.

We may now describe in outline the organisation of a few typical farms, and it seems most convenient to begin in the mountains and work downwards to the plains.

The typical mountain grazing extends to some thousands of acres, and each shepherd has a flock of perhaps five hundred breeding ewes which, in an average season, will produce over four hundred lambs. On the higher grazings the breed is uncrossed Blackface. The " top " ewe lambs are normally retained for breeding, but are sent down to the lowlands in November to be wintered on pastures, returning home in April. The " second " ewe lambs are sold to other hill farmers, on somewhat better land, who cross-breed with the Border Leicester. The wether lambs are sold in late summer and autumn to lowland farmers for fattening. The ewes are disposed of generally at five and a half years old, and all that are healthy are bought for breeding by farmers in the semi-arable upland districts, being crossed with the Border Leicester to produce " Greyface " lambs. The mountain grazings may carry a few ponies and occasionally some cattle.

The farms of the glens and hill-foot districts are both large and small. The better fields, and those lying near the homestead, are worked on the alternate system, the duration of the ley varying greatly. The ley is broken in autumn and sown with oats in spring ; in the following year the crops are turnips and swedes, with usually a small area of potatoes ; following this is a further crop of oats, with which is sown a grass-seeds mixture including wild white clover. The cattle stock generally consists of Aberdeen Angus or Cross-bred cows, which are mated to Angus bulls and suckle their calves. If the arable acreage is small the calves are sold in autumn, but if there is a sufficient supply of roots and straw they are kept round till spring. There are large special sales of such calves or " stirks " at Blairgowrie, Kirriemuir, etc., and since the quality of the stock is remarkably high, buyers come from long distances and high prices are realised. On all the larger upland farms flocks of ewes, generally Blackface, are maintained, and produce Greyface lambs to Border Leicester rams. The young cattle, lambs, and wool, with an occasional Clydesdale colt, and in some cases a relatively small quantity of potatoes (mainly for seed) provide the whole income.

Descending a further step we come to a zone where the great bulk of the land is arable, and where the traditional rotation is a six course—oats after ley ; turnips, swedes, and potatoes ; oats with grass seeds ; and a three-year ley, part of the first year's grass being mown. Here the main income is still derived from livestock, but there is a wider choice of the particular enterprises, and there are normally sales of both potatoes and oats. If cattle are bred they are generally carried on to two years old and sold fat in spring. In other cases young stores are purchased, reared, and fattened. Where there is a convenient market for milk a dairy herd is an alternative possibility. On the larger farms there is normally a breeding flock of Greyface or Half-bred ewes, which are crossed with Suffolk or Oxford rams. The lambs may be sold as stores, or fattened in winter on roots. Numbers of Blackface and Greyface lambs are also purchased from the hill farmers, and are fattened on latter-maths and roots.

The typical farm of the lowland loam areas, such as Strathmore and the coastal belt of Angus, is rather large—perhaps three hundred acres in extent—and employing eight or nine men. The traditional rotation is a seven course, which runs as follows :—(1) Oats are taken after a two year ley, and are followed (2) with potatoes, which receive the bulk of the farmyard manure with perhaps 6, 8, or 10 hundredweight of artificial. The varieties are chiefly maincrops such as Majestic, King Edward, Kerr's Pink, and Golden Wonder. The potato crop is easily the largest single source of income. Majestic and King Edward are grown mainly to produce seed for the English market. Next (3) follows wheat, which can rarely be sown till the latter half of November, and which may get 2 or 3 cwt. of mineral fertiliser in autumn and a dressing of nitrogen in late spring. The wheat is succeeded (4) by turnips and swedes, or partly by sugar beet, which crops may receive light dressings of dung, but in any case get rather liberal doses of fertiliser. Next (5) comes oats or barley, the choice depending on the character of the particular field and the prospects for barley prices. With this grain crop is sown the grass seed for a two year ley (6 and 7).

As in other districts, there is now a tendency to depart from a strict succession of cropping and, in particular, to leave the ley down for three or even four years.

Up till the period of the war almost the only livestock on these lowland farms, apart from the work horses, were fattening bullocks. The farmer reckoned to feed in winter two or perhaps three bullocks on each acre of his root crop, along with oat straw, a very little hay in the last stages, and an allowance of 4-8 lb. per head per day of cake and other concentrates. A further batch of stores was bought in spring and fattened out on grass. The district is far from being self-supporting in the matter of store cattle, large numbers of Irish being imported both in autumn and spring.

With the long continued depression in beef prices, the livestock has become much more varied. In the vicinity of towns, and even fairly far afield, there are dairy herds. " Regular " breeding flocks, except pedigree flocks of Border Leicesters, Suffolks, and Oxfords, are not very common, for the ewes tend to get too fat. Most farmers, however, have flying flocks of Half-bred or Greyface ewes for the production of fat lamb. Considerable numbers of lambs and tegs are also bought and fattened. Large-scale pig breeding and poultry keeping are rather uncommon, though numbers of fowls are increasing.

The general standard of farm building and equipment is high, for there was great enthusiasm for improvements on the part of the landowners throughout the period 1760-1890. The tenants are progressive and hard-working men, and it is doubtful whether keener or more highly skilled workers are to be found in any part of this country ; nevertheless, the area has suffered, in full measure, the effects of recent depression, and is probably less prosperous now than it has been for a century and a half.

VII.

PREHISTORIC ARCHAEOLOGY OF THE DUNDEE DISTRICT

BY

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Mesolithic. The earliest reliable traces of man so far recorded in Scotland date from the ill-defined period after the Quaternary Ice Age which archaeologists term " mesolithic." To an early phase of this period might be assigned on geological grounds a canoe hollowed out of a trunk of Scots' fir with the aid of fire which was found " a number of years " before 1879 at Friarton brick-works, Perth, beneath 10 ft. of estuarine silt on a bed of peat. The silt is equated by James Geikie with the carse clays, admittedly laid down in the period of marine transgression represented elsewhere by the " 25 ft. raised beach " and coinciding with the Atlantic or Lower Turbarian phase of climate. The underlying peat was presumably formed before the transgression in the preceding Boreal or Lower Forestian climatic phase. Assuming that the dug-out canoe came from this peat, it would be contemporary with Continental sites such as Maglemose and Kunda, and anterior to 5000 B.C.

No other associated relics, found in our area, can be dated to the mesolithic with any confidence. But a few pigmy flints or microliths from Tentsmuir may belong to the Tardenoisian culture which appeared in England first in Boreal times, but even there persisted very much later.

The Neolithic Period is represented by no connected remains in the area here surveyed. Certainly there are plenty of polished stone axe-heads, the type fossil of the New Stone Age for typologists, but such notoriously remained in use during the subsequent metal ages. In fact the only specimen found in a definite association in our area comes from the Iron Age fort at Abernethy (p. 61). Similarly flint arrow-heads of the leaf-shaped type, which alone was current in neolithic Britain, is commoner than the tanged-and-barbed variety that came in first with the Beaker invaders at the beginning of the Bronze Age. In a representative sample collected in Angus, 61 arrow-heads are leaf-shaped, only 42 tanged-and-barbed ; from Tentsmuir, Fife, St. Andrews University Museum possesses 12 of the former type and 40 of the latter. Grave-finds, however, prove that leaf-shaped arrow-heads were not confined to the Stone Age, but were used quite late in the Bronze Age, too. For similar reasons cushion-shaped mace-heads, represented by three examples in our area, cannot be accepted as certainly neolithic in age.

Bronze Age. It is first in the Early Bronze Age that connected finds clearly attest human settlement in Strathmore, along the Tay estuary and in northern Fife. The period is conventionally taken as beginning with the

arrival in Britain of the round-headed Beaker folk coming from the Continent. The characteristic vase that gives its name to the invaders is represented in 20 burials in our area. It is now admitted that the Beaker folk reached Britain in two quite distinct waves, each doubtless composite. The first wave is characterized by B beakers, the profiles of which form a continuous S curve. Such are well represented on both sides of the Tay estuary; cord-ornamented beakers from Law Park, St. Andrews, Tentsmuir, and Castle Huntly are related on the one hand to some from northern Holland, on the other to well-known examples from the Lothians, Peeblesshire, and south-western Scotland. In Strathmore beakers of all types are rare in comparison with food-vessels and most belong to the AC family. Their distribution is conspicuously inland, not coastal. Mrs Stewart (Mitchell) holds that their makers came by land either from Aberdeenshire or from south of the Forth. The striking similarity of the AC beaker from Greenhill, Balmerino, to one from Midlothian enhances the probability of the second alternative.

Food-vessels are typical of a second culture generally later than the Beaker-cultures, but certainly overlapping with them. This overlap may be documented from local material. A beaker from Idvies, Angus, has an internally bevelled rim, proper to food-vessels, and accompanied a cremation interment. The jet necklace associated with the beaker at Law Park agrees precisely with those associated with food-vessels in no less than six instances. The region here surveyed boasts at least 30 food-vessels as against 20 beakers, though, owing to their much softer clay, these vases have a much poorer chance of survival. Of the two groups into which it is now customary to divide food-vessels, five might with some confidence be ascribed to the Yorkshire series (with grooved shoulder) and nine to the Irish family. A double groove spanned by pierced stop-ridges is an interesting feature in the food-vessel from Sandyford, Kirriemuir.

Apart from a few camping places on Tentsmuir, habitation sites of the Bronze Age are unknown. The vessels described all come from graves. The rite was either contracted burial, usually in a short cist, or cremation. Beakers generally accompany inhumations, but at Idvies, and perhaps at Collessie, were associated with burnt bones. Many food-vessels, too, have been found with unburnt skeletons in cists, but rather more frequently accompany cremations.

Three burial cairns deserve especial mention. That at Collessie was originally 40 ft. high and 120 ft. in diameter. An irregular semicircle of slabs on edge, open to the west, was buried under the cairn which was erected on artificially levelled ground covered with a bed of laid clay. A central cist on the ground contained a skeleton and an AC beaker; a pit dug into virgin soil to the west contained a BC beaker, and a second pit, still farther west of the centre, held cremated bones and a triangular knife-dagger with gold-capped pommel. A cairn at Greenhill overlooking the Tay above Balmerino was 50 ft. in diameter and sustained by a peristalith. Near the centre it covered an upright stone standing 3¼ ft. high and, immediately to the west of this, an empty cist. Nearer the circumference were deposits of cremated bones, parts of two "jet" necklaces and seven food-vessels, two of which filled with cremated bones had been covered with a wooden lid. In Angus a great cairn on the Sidlaws above Wester Mains of Auchterhouse covered a double cist containing cremated remains and a bronze dagger with a horn

hilt. The cist was buried in a mound of fine black earth, 20 ft. in diameter, and delimited by a ring of boulders. This in turn was covered by a pyramidal cairn supported by a peristalith, 62 ft. in diameter. In other parts of Scotland beaker and food-vessel interments have been found in stone circles. No such association is attested here, and in fact very few stone circles survive. Stones at the smithy at the foot of Pitscandly Hill on the old road from Forfar to Brechin probably represent the remains of such a circle.

Beyond clay urns, the furniture rescued from our Bronze Age graves is relatively poor. But our area has yielded no less than eight " jet " necklaces, one composed of disc beads, the remainder of several strings of barrel beads separated by decorated spacer-plates. An amber bead, now lost, is reported to have been found in a cist near Dundee. Of metal we have flat bronze rivetted daggers from Collessie and Linlathen, and a more advanced weapon with a midrib and hilt of ox-horn from the cairn at Auchterhouse (p. 59). The latter weapon is already a type proper to the early Middle Bronze Age and the gold mount of the Collessie blade agrees precisely with that attached to a Middle Bronze Age blade from Arran. As we shall find that a Middle Bronze Age as a distinct typological period cannot be distinguished in our area, we have to reckon with the possibility that the beaker-food vessel phase in the funerary record covers both the Early and Middle Bronze Ages as defined by hoards south of the Forth.

With this reservation we may supplement the funerary record by a reference to metal objects of Early Bronze Age type collected stray in the Dundee district. It has yielded 11 flat axes (five from Angus and five from the vicinity of Perth) and seven rivetted knife daggers, including the three grave-finds already mentioned.

As in the rest of Scotland north of the Forth, developed types such as define the Middle Bronze Age in England are represented only by a few strays. No rapiers have been found north of the Tay at all, but one from Dunshelt, Auchtermuchty, falls just within the southern border of our map. I know only 4 winged axes, 4 palstaves, and 2 spear-heads with loops on the socket from the area under review.

Late Bronze Age types on the other hand are relatively numerous and bear witness not only to an increased population but also to renewed intercourse with the Continent, England, and Ireland. Hoards indicate the role of Strathmore as an artery of commerce. From the list recently published by Mr Henderson I can cite 15 socketted axes and 20 leaf-shaped swords. Five swords from the Tay below Perth may point to the estuary as a port of entry for this exotic type. That from Migdrum I. is the only U type sword from Scotland. The rest belong to the V type—a later and distinctively Britannico-Hibernian derivative of the more Continental U type. Of the axes, one from Strathmore is explicitly connected with Fox's " Yorkshire " group, while another is no less distinctively Hibernian. The remaining tools and weapons belong to the usual Britannico-Hibernian repertory, though the great spear-head with lunate openings in the blade from Denhead deserves mention as an unusually fine specimen of this well-known type. In the Balmashanner hoard Irish gold is associated with Baltic amber and bracelets with asymmetrically expanding ends that Miss Benton claims as a Central European form.

While the Late Bronze Age bronze implements suffice to mark a distinct typological period, the increase in population since the earlier phase of the

Bronze Age is better illustrated by burials. These now take the form of cremation interments in Cinerary Urns, seldom enclosed in a cist or surrounded by a circle or covered by a cairn. Such coarse unprotected vessels are peculiarly liable to unrecorded destruction (at many places the Six Inch Ordnance Maps mark " many urns found here "), so that statistics of their numbers and distribution would give no accurate idea of the density of population or areas of settlement. In Fife and along the Tay such cremation interments are regularly grouped in cemeteries or " urnfields." Thus at Law Park, St. Andrews, there were at least 20 urns, at Breckmont Mill, Leuchars, 13, at Carphin House, 22. At Carphin House 15 urns were arranged in a row. At Westwood, Newport, the urns formed a circle. The groups reported from Strathmore are smaller. At Gilchorn, Arbroath, there were six, all under a cairn.

It is perhaps needless to invoke an invasion by " urnfield folk " to explain this grouping of burials. Grouped burials have already been mentioned in Fife in the previous phase at Balmerino and Collessie. In other cases, too, it looks as if the urn burials may have been planted in a cemetery used in the earlier Bronze Age. So at Law Park the urnfield was in the same field as the cists containing the beakers previously mentioned. At the foot of Tealing Hill two Cinerary Urns (of the Enlarged Food-vessels form) were found directly over, but 3 ft. above a cist containing an unburnt skeleton. The urnfields contain urns of all types—enlarged food-vessels and their derivatives the encrusted urns and members of the overhanging rim family from early types with well-marked neck and shoulder to the supposedly late cordoned urns.

Urn-burials seldom contain relics, but those recovered are important. From Mill o' Marcus comes a segmented bead of fayence diagnosed as Egyptian by Beck and Stone, though admittedly different from the type so freely imported into Wiltshire about 1400 B.C. An urn at Gilchorn contained a small bronze blade with two notches at the base and a midrib on one face only, curiously like a type current in the Copper Age of southern Spain and Portugal that was imported to Denmark while that country was still in the Stone Age.

Making due allowance for the destruction wrought by intensive agriculture, for the inertia of collectors in the region, and for the appalling lack of systematic excavation, the Dundee district and Strathmore do not seem to have been at all thickly populated in the Bronze Age. Presumably the most fertile lands were too thickly wooded and too marshy for tillage or pasture till the introduction of economical iron-working made durable metal tools cheap enough to be available to every farmer and pastoralist.

Iron Age. At least 30 forts and no less than 13 " earth-houses " are known in our area. Of course, not all of these need be contemporary; the Iron Age lasts from 200 B.C. to any date you like in the post-Roman Dark Ages. So few forts have, however, been excavated scientifically that they can only be classified on the basis of their visible external features. Adequate data for assigning any particular class to one period rather than another within the vague Iron Age are still missing.

The earliest dateable relic of the Iron Age known from Scotland is a brooch (fibula) of La Tène I. type found in the fort on Castle Law, overlooking the Tay estuary above Abernethy. This sort of brooch had been

elaborated among the Celtic peoples of Central Europe and Eastern Gaul during the 4th and 3rd centuries B.C. and was superseded by a new fashion about 200 B.C. Our specimen is more like some from Switzerland than any English brooch. The same fort yielded also some corroded tools and weapons of iron, a very thick runner ring of jet (lignite), a grooved bracelet of the same material, a bronze finger ring, and a ring-head pin of iron—all objects appropriate to the Celtic La Tène cultures of the Continent, with no sort of roots in the local Bronze Age tradition. The fort itself is a mature example of a system of fortification developed on the Continent. The summit of the law is defended by two walls of similar construction. The inner rampart is 18 to 25 ft. thick and faced with masonry walls inside and out. In the outer face a double row of rectangular beam-holes is still visible. They once held timber beams which ran transversely through the wall and tied the two faces together. The space between the faces was filled with rubble and timbers. Such a rampart is often termed a Gallic wall and approximates in structure to what Caesar describes in his Commentaries on the Gallic war. A fort on a hill above Forgandenny a little further west is similarly defended.

Experiment has shown that a Gallic wall can be set on fire and that the heat generated in its combustion suffices to melt the rubble of the core if the rocks are not too refractory. It is therefore likely that the so-called vitrified forts, characterized by the presence of masses of stone fused together in the wall-cores, are just burned Gallic forts and were erected at the same period. At least five forts in our area have partially vitrified walls, but only Finavon, near Forfar, has been explored by modern methods. The citadel takes the form of a trapeze-shaped enclosure on the top of an uneven hill. The long north and south walls run dead straight for 300-400 ft. regardless of the natural contours of the summit. The actual walls, now buried in debris, are 20 ft. thick, faced on both sides with superb masonry still standing in places 8 ft. high, and must originally have attained the imposing elevation of 16 ft. The blocks of vitrified material now visible have all fallen from the higher courses of the ramparts, but excavation disclosed a few blocks probably *in situ* in the core near the top of the surviving masonry. A well at the east end (now exposed), cut through the living rock to a depth of 20 ft., yields no water. It had been filled up as useless by the fort's occupants, who then dug the well at the west end (which contained water last century till a farmer filled it in) and extended the defences to incorporate it. Very coarse pottery quite unlike any Bronze Age fabric, flint scrapers, spindle whorls, crucibles, scraps of iron were recovered, but the only indications of date were a thick "jet" runner ring, like that from Abernethy, and the absence of Roman pottery.

By analogy the huge hill-top town or *oppidum* on Turin Hill, covering 14 acres, should also be pre-Roman. Its defences, apparently a wall of the terraces type such as is seen at Stradonitz in Bohemia and in Scotland in the pre-Roman fort on Burnswark, are quite unlike those of Abernethy and Finavon and slavishly follow the contours of the hill. Within the original enceinte are later structures in a much better state of preservation—notably the ring-fort noticed below.

Three small ring forts with stone walls 12 ft. thick enclosing an area 27 ft. in diameter—Hurley Hawkin, St. Bride's Ring, and the Laws, Monifieth—have been called brochs. They reveal, however, no trace of the guard-cell

and spiral intramural staircase that constitute the sole reliable diagnostic symptoms of a genuine broch. I believe these forts, together with one in the enceinte on Turin Hill, another on Pitscandly Hill, etc., should be connected with a well-known series of stone ring-forts in central Perthshire that can be traced along Loch Awe to the west coast in Argyll, and that resemble in a general way Irish cashels. The " broch " near Monifieth stands within a complex system of masonry walls partially vitrified. Somewhere at the site an early ring head pin was found. The broch may here be an intruder in an earlier work as is the ring-fort on Turin Hill.

An earth-house (also called a *weem*, and in Ireland and France a *souterrain*) is a gallery built in an excavated trench generally walled with unquarried boulders and roofed with large lintel stones covered over with earth. All must have been attached to steadings or small hamlets built above ground, but these have not survived. The group of 13 in our area north of the Tay constitutes one of the largest concentrations of earth-houses in Scotland. At West Grange of Conan a corbelled beehive-cell, 11 ft. in diameter and 7½ ft. high but also subterranean, opens off the main gallery just as at Castle Law, Glencorse, and at Chapel Euny in Cornwall. Cup-and-ring marked stones are included in conspicuous positions in the walls at Pitcur and Tealing ; a serpent is carved on a lintel at Barns of Airlie. As such markings are generally Bronze Age in date, these carved stones may have been re-used in making the earth houses. Fragments of *terra sigillata*, including some first century pieces from West Grange of Conan, show that these earth-houses were occupied during the Roman period.

Roman Period. In 83 A.D. the legions under Agricola penetrated Strathmore, and it was perhaps in this region that the Roman general won his famous victory at Mons Graupius. As monuments of their mastery over Strathmore the Romans have left a line of camps beginning at Inchtuthil, near Perth. None of those in Strathmore has been excavated and the duration of Roman control over this area is still uncertain.

Dark Ages. Hill forts were not necessarily abandoned when the Romans departed. Indeed, I would attribute to the post-Roman period the ring-forts mentioned on p. 62 and also the erection of a souterrain in the fort at Dunsinane ; for this is a distinctly Irish feature, like the ring-forts. Both may be monuments of an early infiltration of Scotti into Pictavia. Of the traditional Dalriadic eponyms, Loarn (who gives his name to Lorne) had a brother Angus, Comgall (Connell) a brother Gabran. The name of the first may survive in Angus, that of Gabran in Gowrie ; Gabran is indeed said to have been defeated by Brude, King of the Picts. But the period after 400 A.D. is the least known in Scottish prehistory, the darkness of which is only emphasized by these tantalizing references in late and suspect chronicles.

In Angus and Perthshire its obscurity is to some extent relieved by the so-called Pictish symbol stones and cross slabs, peculiar to the north and east of Scotland and represented by a magnificent group of over 55 monuments in our area. The former monuments bear two or more of 14 symbols, including geometrical and compass-drawn figures (the Z and V rod, the, crescent, conjoined circles, . . .), representations of mirror, comb, hammer, and anvil, and stylized animals—serpent, wolf, and a fantastic beast resembling an elephant. These are generally incised on natural boulders, rude standing stones and cave walls, but occur also traced on bone or metalwork. Few

examples of symbols engraved alone occur in our province. Here they are more often carved on dressed slabs bearing on one side a cross and combined with Irish interlacing work and sculptures in low relief depicting ecclesiastics, warriors, centaurs, strange beasts, biblical and hagiographic scenes, battles, and hunts. Frequent occurrence in churchyards suggests, not necessarily use as gravestones, but at least a regular association with Christian cult. Yet a stone at Meigle seems to represent the Celtic god, Kernunus.

The engraved symbol-stones are generally supposed to be purely Pictish and have been dated as early as the third century. But even in them, Christian symbolism has been detected by many authorities. The mirror and comb are common on pagan Roman stones, but also on early Christian monuments; the form of our mirror is, however, La Tène. On the cross-slabs the symbols are combined with explicitly Irish ritual and artistic traditions and perhaps also motives borrowed from Northumbria. But even on them the style of the figural carvings is peculiar and distinctive—presumably Pictish. A date in the eighth century for the main group to be visited by the Association is not improbable, but some must be later and substantially lower dates have been seriously advanced. Dating depends, however, on minute stylistic comparisons which cannot be discussed here.

VIII.

MEDIAEVAL AND RENAISSANCE ARCHITECTURE IN THE DUNDEE DISTRICT

BY

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(a) Ecclesiastical.

The cross-slab symbols mentioned at the end of the previous article have been assigned to the period 800-1000; to the eleventh century and the early part of the twelfth belongs another type, similar in design but without the symbols, and sometimes displaying a vine-scroll beside the zoomorphic ornament. A large collection of these later cross-slabs is to be found in the Cathedral Museum of St. Andrews. But no vestige of the dark little churches beside which these stones were erected is to be found in this part of Scotland. At Brechin, however, the builders of the thirteenth century cathedral spared the round tower, over 86 feet high, which the Celtic monks had erected after a disastrous raid at the beginning of the eleventh century. The narrow doorway, six and a half feet above the ground, with its semicircular head scooped out of a single stone, the internal string courses which supported the floors of the seven rooms into which the tower was divided, the small windows with inclined jambs which lighted the lower rooms, the four rectangular windows under the parapet facing the four cardinal points—are all features which suggest an Irish original. A similar round tower, about 72 feet high, stands at Abernethy. The upper portion, however, seems to have been rebuilt, for the four round-headed windows below the parapet are distinctly Norman in character.

With the exception of these towers, the oldest ecclesiastical buildings in the neighbourhood of Dundee date from the reign of David I. (1124-53), the half-English monarch, educated at the court of a Norman king, who began a peaceful Norman Conquest of Scotland which led to the establishment of the new religious orders either in the old Celtic monasteries or in completely new foundations, and to the consequent displacement of Celtic monks by Normans or Englishmen. An Augustinian priory, for example, was founded at Restennet, Augustinian canons were introduced into St. Andrew Cathedral, and though the Culdees—who may be called Celtic Canons Regular—were allowed to remain at Brechin, their church became the cathedral of a new diocese. The policy of David I. was continued by his grandsons, Malcolm IV. (1153-65), who founded the Cistercian monastery of Coupar Angus in 1164, and William the Lion (1165-1214), who in 1175 founded a great Benedictine Abbey at Arbroath. A third grandson, David Earl of Huntingdon, transplanted to Newburgh the old Celtic monastery of Lindores, now reorganised as a

Benedictine abbey. The Cistercian abbey of Balmerino was founded by Ermengarde, the widow of William the Lion, and her son, Alexander II., in 1229.

Of these " pious edifications " only tantalising fragments remain—at Coupar Angus the gatehouse and the bases of some of the nave piers, at Lindores the rubble core of the walls of church and cloister, while at Balmerino the abbey church has been reduced to its foundations, though the pillared vestibule of a fifteenth century chapter house, and the roofless shell of the chapter-house itself, have been preserved. But enough remains to show that there had been a clean break with Celtic tradition, and that the craftsmen who at St. Andrews and St. Vigeans used the Celtic cross-slabs as building materials looked to England for their inspiration and followed the English architectural fashions of the day before yesterday. Thus the square, plain, slightly tapering twelfth century tower of Restennet, with its traces of long and short work, its windows with inclined jambs, and the semicircular arch, scooped out of a stone slab laid on edge, which surmounts its south doorway, is reminiscent of the Romanesque churches that were built in northern England on the eve of, or immediately after, the Norman Conquest. Rounded window heads carved out of the lintel and other archaic features appear in the unadorned but strangely impressive church and tower of St. Regulus at St. Andrews, which Bishop Robert built in the second quarter of the twelfth century. He took as his model, it would appear, the early twelfth century church of Wharram-le-Street in Yorkshire.

Of the smaller Norman churches little is left in Angus—a few courses of masonry at St. Vigeans, a characteristic window and chancel arch at Lundie —but in Fife, Leuchars Church retains its richly ornamented late Norman apse and chancel.

The outstanding example of Transitional and Early English work in the area was St. Andrews Cathedral, begun in 1160 and completed, as a great cruciform church, measuring 391 feet from east to west, about a hundred years later. The nave was shortened by two bays in the time of Bishop William Wishart (1273-79), who erected the present west front and substituted pointed windows for the Transitional windows in the south-western bays of the nave. The upper part of the west front, however, was reconstructed at the end of the fourteenth century, to which period also belong the east window which replaces two of the original three rows of Transitional windows which pierced the east gable. Unfortunately, beyond the bases of walls and piers nothing is left of the church but the east gable, the west wall of the south transept, the south wall of the nave, and part of the west front. A doorway and its two flanking windows remain to give one some idea of the pure, serene beauty of the thirteenth century chapter-house, but of the other conventual buildings only the foundations are left, encased in the red sandstone of late nineteenth century restorations.

At Arbroath Abbey, " once of great extent and stupendous magnificence," the west front with the tall lancets of the twin towers and its pillared gallery above the deep-set, round-arched doorway is almost intact ; so is the south transept, with its strange mixture of architectural styles—round-headed arches above pointed arches—great soaring lancet windows in its western wall. As at St. Andrews, the choir terminated in an aisleless presbytery, much of which has been preserved, and though only an angle of the chapter-house

is left, and the very foundations of other conventual buildings destroyed, Arbroath has been fortunate enough to retain, embedded in a later medieval building, one of the earliest examples of domestic architecture in Scotland, the thirteenth century Abbot's Hall. At Restennet, too, the twelfth century church was demolished, and the west tower became the central tower of a long, narrow church in the Early English style, without towers or transepts. Of the thirteenth century church the roofless choir and the foundations of the nave still remain.

When Brechin Cathedral was completed in the thirteenth century it consisted of an unusually beautiful aisleless choir, eighty-four feet long, and a nave of five bays, with clerestory windows, but without a triforium gallery. The massive square south-western tower which balances the older round tower on the other side of the deeply-recessed Early English doorway was probably completed, except for the spire, in the third quarter of the fourteenth century. After the Reformation the choir was allowed to fall into ruin, but the nave was preserved for use as a parish church. Like many other churches in Scotland, Brechin suffered less from the seventeenth century reformers than from the early nineteenth century restorers. Most of this mischief has been undone in our time, and Brechin survives to show that the medieval craftsman could make a comparatively small building carry an impression of spaciousness and calm dignity.

Though the thirteenth century saw the establishment of Franciscan convents in Dundee and St. Andrews and Dominican convents in Dundee and Perth, little remains of these foundations, and that little is much later than the thirteenth century. In Dundee we have the Howff, a sixteenth century graveyard which was originally a " place or yaird . . . occupyet by the Grey Cordeliar Freris." Little more is left of the parish churches built in the thirteenth century ; the roofless, ivy-clad church of Abdie, near Newburgh, is almost the only example.

The death of Alexander III. in 1286 marks a break in the development of ecclesiastical architecture in Scotland. Not only had the impulse to found cathedrals and monasteries spent itself ; the war with England, which dragged on for a quarter of a century after Bannockburn, left the country demoralised and impoverished. The architectural history of the fourteenth century is almost a complete blank ; old churches might be destroyed in war—like St. Mary's, Dundee—but no new churches were built, though the Pends at St. Andrews and a similar great gatehouse at Arbroath now protected the entrance to Priory and Abbey. Not till the second decade of the fifteenth century did the erection of great churches recommence, and then, it should be noted, the builders no longer drew their inspiration from England. Looking sometimes to contemporary France, sometimes back to the older churches of their own country, they evolved a distinctive architectural idiom. Thus Holy Trinity Church, St. Andrews, though it is the restoration of a restoration, retains some of the original cylindrical piers and semicircular arches which testify to the fifteenth century architect's fondness for twelfth century forms. The semicircular arch appears again in the clerestory of the choir of St. John's Church at Perth, and in the doorway of St. Mary's Tower in Dundee. French influence is evident in the trigonal apse of St. Salvator's Chapel, built in 1450, and in the splendid canopied tomb of its founder, but

the sacrament house on the right of the tomb, the three trigonal arched doorways, and the massive buttresses which upheld the heavy barrel-vaulted roof and its covering of flagstones, are specially characteristic of the country and the period. The barrel vault has been replaced by a timber roof, but in the neighbouring chapel of the Blackfriars one can see the pointed barrel vault with ornamental ribs applied to it, built by craftsmen who had lost the art of constructing a true groined roof.

While the great thirteenth century churches were raised by some prince or prelate, most of the notable fifteenth century churches bear witness to the growing wealth and civic pride of the burghs. In St. Andrews, in Cupar, in Perth, in Dundee arose the western towers of great new churches, where the aisles in nave and transept were screened off to accommodate the multitude of chapels maintained by the piety of craft gilds or private families. Holy Trinity in St. Andrews was built in 1411, St. Michael's, in the neighbouring burgh of Cupar, in 1415. Of the latter only the western tower and three arches of the nave are left, but Perth has preserved and restored to much of its pristine beauty the church of St. John the Evangelist. Here, however, lack of funds forced the burgesses to modify their original plans, and so a dark, low-browed nave of five bays, the last part of the church to be built, leads to a lofty choir, with massive piers, great windows filled with curvelinear tracery, and a hammer-beam roof. Though one notices here the corbels which supported the rood loft and, in one of the four great piers supporting the tower, the door and stair communicating with it, the rood and rood screen themselves, with all the original woodwork, stained glass, and wall-paintings have vanished from St. John's as from all churches in our area. Only the little village church of Fowlis Easter retained till late in the nineteenth century its rood screen with carved wooden doors and painted panels of apostles and saints, and the great picture of the Crucifixion which surmounted it. The late nineteenth century restorers dismembered the screen but preserved the fragments ; the doors have been fitted into a modern screen and the painted panels hung on the walls of the church.

Nowhere was the growth of civic pride more apparent than in Dundee itself, where the parish church belonged to the monastery of Lindores. In 1442 the burgesses agreed to relieve the Abbot of his obligation to maintain the choir in good repair, and proceeded to build a great cruciform church, which they completed about half a century later by the erection of the massive western tower 165 feet high—that Old Steeple which is one of the glories of Scottish architecture. But of the original church there have survived only part of the north wall of the nave, including the north doorway, and a few late medieval tombstones which are preserved in Dudhope Museum. The nave was battered down by the guns of an English fleet in 1547, the choir and transepts, which in the economical Scottish fashion had been divided between two congregations, were destroyed by fire in 1841.

Apart from Fowlis Easter, the most interesting of the smaller parish churches in this area is St. Vigeans—which, though it contains some Norman masonry and a multitude of Celtic cross-slabs, is substantially a late fifteenth century structure, with the cylindrical piers and circular arches which repeat an earlier fashion. But the chapel of the suppressed college of St. Leonard in St. Andrews, with its square-headed mullioned windows, is one of the rare

Scottish experiments in the Perpendicular style, and it was not built till the early years of the sixteenth century.

With the Reformation—all the more violent because it was long delayed—the interest shifts from ecclesiastical to secular architecture. Though the Reformation destroyed the monasteries it spared the parish churches—their destruction was delayed till the end of the eighteenth century or later—but it left only the shells of the buildings—stained glass, mural paintings, statues, rood screens, and choir stalls—all were destroyed. Large churches, like St. John's in Perth or St. Mary's in Dundee, were partitioned off to accommodate two, three, or four separate congregations; large and small churches alike were darkened by deep lofts or galleries. But here and there some example of honest craftsmanship—the late sixteenth century pulpit in St. Salvator's Chapel, the ornate seventeenth century spire of St. Michael's, in Cupar, shows that the love of beauty had not wholly died out of the Scottish Church. A more ambitious attempt to recover a lost architectural tradition can be seen in the curious imitation medieval church built at Dairsie in 1637.

(b) Secular Architecture.

The sixteenth century Scottish castle bore little resemblance to its twelfth century prototype. This was a mote and bailey castle, similar to those which were erected in England immediately after the conquest, a structure of timber planted on a mound and encircled by a palisade. The mound might be natural, as at Dundee, where a little eminence beside the river, the original Celtic *dun*, became the Castlehill of later medieval times. The timber superstructures have long since been swept away, but the mote itself can still be distinguished at Leuchars and at Edzell.

The mote and bailey castle remained the commonest type of Scottish castle down to the end of the thirteenth century. Only here and there was it replaced by the enceinte castle, with thick stone curtain walls and massive flanking towers at the angle. At Kinclaven, near the junction of the Tay and the Isla, the curtain walls of a castle of this type are still standing, though the angle towers have disappeared, and there may be fragments of a thirteenth century wall of enceinte in Redcastle on Lunan Bay, which is mainly a fifteenth century structure.

The War of Independence affected secular architecture as it had done ecclesiastical architecture—directly by the destruction of existing buildings, indirectly by the impoverishment of the country. The Castle of Dundee, thrice occupied by English troops, was demolished by the command of Robert the Bruce and never rebuilt. It is significant that there are few examples of fourteenth century castles in our area, and that the late fourteenth and early fifteenth century castle is a modest structure, a single tower forming one side of a courtyard, the other three sides of which were enclosed by a barmekin—a high stone wall. The tower, which was square in plan, rose sheer to a projecting parapet supported by corbels. A yett or grille of wrought iron and a stout wooden door closed a single entrance. Within, the principal apartment, the hall, was on the first floor, above the vaulted basement containing the kitchen and storerooms. Access from the hall to the basement and the upper floors was provided by a narrow turnpike stairway; another stair led from

the hall to the wine cellar beneath, which could not be entered from the basement. Dungeon-like bedchambers were constructed in the thickness of the walls.

About the middle of the fifteenth century the square plan was superseded by the L shaped plan—the tower was now built with a wing, projecting from it at right angles, the lower part of which often contain a broad scale and platt staircase leading to the hall, while the upper rooms were used as bedchambers. This addition strengthened the castle against attack, as it commanded one and sometimes two faces of the tower, and protected the entrance doorway, which was usually placed in the re-entrant angle. The fifteenth century castle of Affleck is one of the earliest, as it is one of the best preserved, of those L towers in the neighbourhood of Dundee. Here, however, the wing, which contains on one floor an oratory and on another a garderobe with a loophole commanding a view of the hall, projects only a few feet from the front of the main building.

Castles after the pattern of these fifteenth century square or L shaped towers continued to be erected all over Scotland down to the second half of the seventeenth century. They can be counted by the dozen in the neighbourhood of Dundee, sometimes, as at Parbroath in North Fife, reduced to a fragment of masonry smaller than the castle dovecote, sometimes, like Castle Huntly in the Carse of Gowrie or Kinnaird Castle in Angus, surviving in the substructure of a grandiose " Scottish baronial " pile, sometimes, like Broughty Castle, restored so thoroughly as to be a nineteenth century copy of a fifteenth century original. Some, however, like Balvaird Castle near Abernethy and Scotstarvit Tower near Cupar, though uninhabited, are in perfect preservation.

Most of them are comparatively small; if we look for their English equivalent we shall find it in the fortified manor house rather than in the great castle like Warkworth or Warwick. On a much larger scale, however, and built to a different plan, is St. Andrews Castle, the palace of the Bishops —after 1472 the Archbishops—of St. Andrews. The original early thirteenth century castle built by Bishop Roger on the edge of the Scores—the scaurs or cliffs which overlook the bay—was twice destroyed and twice rebuilt in the course of the fourteenth century. In the late fourteenth century castle a cobbled courtyard, pentagonal in plan, was surrounded by a curtain wall with a square tower at each angle. Access to the interior of the castle was obtained by a vaulted passage in the base of the South, or Fore, Tower. It was blocked up in the sixteenth century, and a new entrance made between the Fore Tower and the vanished South-West Tower, but one of the *rainures* through which the drawbridge gaffs projected can still be distinguished. In the first half of the sixteenth century the towers were rebuilt and joined to one another by a range of stone buildings, continuous but for a gap on the western side, including the chapel, the great hall, and the stables. The new buildings were badly damaged in a bombardment by a French fleet in the summer of 1547. The existing facade, with its renaissance details and heraldic panels, is the work of Archbishop Hamilton (1550-71), the last Catholic Archbishop of St. Andrews.

That the Reformation should have given a great impetus to the building of castles is easily understood. All but the merest fraction of the lands and revenues of the Catholic Church, estimated at a third to a half of the total wealth of the country, passed into secular hands. The old families, newly

enriched, added a wing to the old tower or carried it up a storey or two higher ; the new families signalised their accession to the ranks of the lesser gentry by building a new tower. Built of grey or reddish stone with slate or stone flagged roofs, these late sixteenth and early seventeenth century towers seem grim and comfortless beside the many-windowed brick or half-timbered manor houses of Elizabethan or Jacobean England. But though in a lawless and ill-regulated country some attention had still to be paid to security, these towers were designed as dwelling-places rather than as fortresses. They are often placed, like Mains Castle, on the outskirts of Dundee, in some pleasant, sheltered hollow. Sometimes the projecting parapet with its supporting corbels disappears, or is retained as a purely ornamental feature. Sometimes, as at Invermark Castle in Glenesk, angle turrets are substituted, sometimes, as at Claypots near Dundee, where, however, there is a short length of parapet, additional accommodation is secured by making square upper storeys which oversail the round towers from which they spring. The monograms and emblems on skew-put and pediment, the heraldic panels over the entrance door furnish additional evidence that security was not the only consideration in the minds of the builders.

Side by side with the towers appear structures which proclaim themselves to be less castle than mansion house, with panelled walls and plaster ceilings, elaborately decorated, sometimes having on the upper floor a long, narrow gallery, with a curved roof, lined with wooden boards, on which are painted allegorical figures and coats of arms. Such a painted timber ceiling, carefully restored by Sir Robert Lorimer, can be seen at Earlshall, near Leuchars, in the seventeenth century mansion house or hall which confronts the sixteenth century tower on the opposite side of the courtyard. Another, painted with heraldic designs and much decayed, exists at Collarnie Castle in the same county. Conversion first into a cotton mill, then into a barracks, has not altogether obliterated the external features of Dudhope Castle, in Dundee, built in 1600. In its original form the building was a storey lower than at present ; and it enclosed two sides of a courtyard, the other two sides of which were formed by a stone wall which has disappeared. But the two drum towers that flank the pended entrance, and the three round towers at the angles with their conical slate roofs, even now give it something of the air of the Château of Loches in Touraine. The most interesting castles of this latest period, however, are Edzell and Glamis. At Edzell the architect has incorporated the massive early sixteenth century tower into the Renaissance facade of his late sixteenth century mansion house, the dilapidated buildings of which enclose the courtyard on two sides. These can be matched elsewhere ; what is unique in Scotland is the pleasaunce, with its turreted summerhouse, and its charmingly designed garden wall decorated with heraldic devices and with panels representing planetary deities, the liberal arts, and the cardinal virtues, copied by a local mason from some German " Liber Amicorum."

" The house from the height of it," said the poet Gray, " the many towers, the spread of its wings, has really a very singular and striking appearance, like nothing I ever saw." This was while " the huge old towers of Glamis, ' whose birth tradition knows not,' showed its lordly head above seven circles of defensive boundaries " ; before the too enthusiastic landscape gardener " had the cruelty to render the splendid old mansion . . . more *parkish*, as

he was pleased to call it, to raze all those exterior defences, and bring his mean and paltry gravel walk up to the very door," before, too, the high-pitched roofs and crowstepped gables had been removed from the wings of the castle.

The nucleus of Glamis Castle was the usual massive square tower with the projecting wing, or jamb. Its walls were ten feet thick, and three at least of its four stories were vaulted. At the end of the sixteenth century Patrick 9th Lord Glamis (1576-1615) added three more stories to the tower, placed a round tower containing a broad turnpike stair in the re-entrant angle, and built the south-west wing. His son John (1615-47), the tenth Lord, remodelled the interior of the original great hall, and constructed the decorated plaster ceiling which is one of the glories of the castle. Patrick, the eleventh Lord (1647-95), added the north-west wing and the chapel.

" It rises proudly with a cluster of hanging towers." The visitor cannot but be impressed, as Gray was, by the stark grandeur of the cliff-like walls, broken here and there by medallion or heraldic panel, sweeping up to expand into that fantastic cluster of overhanging turrets with high-pitched, pointed roofs, which reminds one not of seventeenth century England but of France, of the medley of towers and arches and pinnacles which crowns the desolate splendour of Chambord.

The existing " Bonnie Dundee," the " Fair City," and the other burghs in the area, for all their long history, are substantially products of the utilitarian nineteenth century. The almost universal use of stone and slate as building materials, the fact that the bulk of the population is housed in tenements—blocks of flats subdivided into two or three rooms—make them seem even more grim and austere than their English counterparts. Though Cupar retains its mercat cross, St. Andrews its West Port, a noble sixteenth century gateway, and Dundee its more dilapidated Cowgate Port, they possess nothing corresponding to the medieval or renaissance guildhalls which we find in English towns of the same antiquity. Dundee did, indeed, boast a Town Hall designed by William Adam, father of the more famous Robert, but this unique example of the work of the elder Adam was destroyed by an iconoclastic Town Council in 1931. Little, too, is left of the original collegiate buildings of St. Andrews except those which line two sides of the charming quadrangle of St. Mary's College. The range on the west side of the quadrangle, built, it is said, by the French workmen who had been employed at Falkland Palace and restored in 1621, retains few of its original features except the homely little College Hall ; while the most attractive part of the early seventeenth century library on the north side is the upper hall with its eighteenth century woodwork. St. Andrews, however, unlike most of the other towns in the area, contains numerous examples of sixteenth and seventeenth century dwelling-houses. They cluster thick at the east end of South Street—manses of cathedral dignitaries like Dean's Court, town houses of country lairds like No. 42 or 46 South Street, houses of wealthy merchants where a queen would not disdain to live, like " Queen Mary's "—now the library of St. Leonard's School.

But St. Andrews and Cupar, like the villages of North Fife, owe much of their charm to the small, seemly, unpretentious houses built of honey-coloured stone, roofed with red tiles mellowed by a century's rains. One sees them everywhere in North Fife ; they seem in perfect keeping with their natural

background, like the reed-thatched cottages in the Carse of Gowrie. Less attractive, but equally in accord with their background, are the sturdy cottages and farmhouses, roofed with slabs of gray stone, scattered about the unsmiling Angus landscape. But here, as in so many parts of rural England, the newer houses seem to be at odds with their surroundings: in a country with abundance of good building stone the bricklayer has been allowed to oust the mason, and cold, blue slate replaces the red tiles of Fife, the thatch of the Carse, and the stone slabs of Angus.

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A SCIENTIFIC SURVEY OF

DUNDEE AND DISTRICT

PREPARED FOR
THE DUNDEE MEETING 1939

BY VARIOUS AUTHORS

Edited by
R. L. MACKIE, M.A., B.Litt.
Training College, Dundee

These surveys, since their initiation in 1932, have been issued to members attending the Meetings, and have subsequently been included in the Annual Reports. The intention in future is to include the survey for the forthcoming meeting in the July issue of 'The Advancement of Science' preceding such meeting; but no survey will be issued in 1940. Meanwhile the Dundee Survey is continued here from Nos. 1 and 2 of 'The Advancement of Science,' and is concluded.

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IX.

THE ECONOMIC HISTORY OF DUNDEE

1.—UP TO 1760

BY

S. G. E. LYTHE, M.A., SCHOOL OF ECONOMICS, DUNDEE.

"SIMPLICITY is the outcome of technical subtlety; it is the goal, not the starting point. As we go backwards the familiar outlines become blurred; the ideas become fluid, and instead of the simple we find the indefinite." These words of Maitland appear as the prologue to one of the outstanding contributions to Scottish economic history, but they apply with equal force to all economic history. The people of any town or country have an economic history going back far beyond historical record, back to the first settlement of men, but in the early phases much is vague and little definite. Only in the later phases, with regional and occupational specialisation, can history be written in firm strokes and with any approach to exactitude. This uncertainty about the earlier phases can, however, be reduced by limiting the study to a small area where geographical factors such as relief and climate have exerted a continuous though often diminishing influence on human activities.

The original settlement of Dundee was probably a fishing hamlet in the sheltered bay between St. Nicholas Craig and the Castlehill, which, before comparatively recent reclamation work, stood out into the Tay. The purpose of this essay is to trace the evolution of the town from the primitive subsistence economy of these fishers to the capitalistic industrial organisation of the present day with its heavy reliance on world commerce. For lack of material the study cannot begin earlier than the 12th century. About that time urban development was proceeding rapidly throughout Western Europe, and it seems that in Scotland as in most other countries the main impulse came from commerce. This early trade in Scotland was conducted to a great extent by foreigners, especially Flemings, who settled in large numbers in Fife and Angus in the 12th century, and in the following century the town of Bruges had a street called "Scotland."

In the charters of David I. certain towns are spoken of as "burgo meo," but the custom of granting individual burghal charters was not common until the reign of William the Lyon (1165–1214), and it was in his reign that Dundee and the neighbouring settlements of Forfar and Montrose were elevated to the rank of royal burghs. It is tempting to overstate the significance of such royal recognition and to give false value to the part of the burghs in the national economy. As late as the 15th century the burghs bore only one-fifth of the total national taxation. Specialisation by countrymen in agriculture and by townsmen in industry and commerce

was but dimly foreshadowed when Dundee and the neighbouring burghs acquired corporate status. Neither industry nor commerce sufficed to maintain their economy, for they were partly, perhaps mainly, agricultural communities, and this urban interest in agriculture could be seen in Dundee as recently as the time of the first Statistical Account. The countryside furnished most of the commodities of trade, indeed the original function of most burghs was the exchange or export of such rural produce.

For this function Dundee was well located. Far enough from the open sea to be safe from storms and piracy, the harbourage within the shelter of Castlehill was as safe as the mediaeval mariner could reasonably expect. The rich agricultural lands of the Carse of Gowrie and Strathmore lay within easy reach by land, whilst the two-mile ferry over the Tay touched the golden fringe of the " beggar's mantle." Little detailed information is available regarding the nature or magnitude of trade before the Wars of Independence. The close connection between Scotland and England at the time is reflected in King John's grant to the men of Dundee of freedom from toll and all other customs of the crown in England except in the city of London (1199). At that time, however, economic conditions in Scotland and in England were more alike than at any other period until modern times, and as early trade was mainly conditional on differences in economic development it is not surprising that Scotland's overseas trade was already orienting towards the industrially advanced regions of Flanders. The authors of " The Scottish Staple at Veere " have emphasised this ; " The history of the organisation of Scottish trade with the Netherlands and its concentration in one town is in a large measure the history of Scotland's foreign commercial relations." The later development of Dundee's trade with the Baltic may be interpreted as a criticism of this sentence, but her trade in the 13th and 14th centuries reveals both Scotland's reliance on the Netherlands and the relative development of the two countries. Dundee was primarily an exporter of the products of the hinterland, hides and woolfells (Coupar Angus was one of the wool-producing houses on Pegolotti's list), and an importer of better-class fabrics, wines, spices, and confections for the nobles and the itinerant royal household. We may surmise that Dundee received raw materials from the Highlands and exported them both abroad and coastwise, though its part in the Highland trade was always rivalled by Perth, indeed, not until 1402 did Perth abandon its claim to a monopoly of the shipping in the Tay. Dundee had not yet attained its greatest relative importance. It was one of the seven burghs represented at Bruce's Parliament at Cambuskenneth, but its Great Customs in 1327 were substantially less than those of Berwick, Edinburgh, and Aberdeen.

The second quarter of the 16th century saw Dundee rise to the rank of second city in Scotland. To a special assessment in 1535 Edinburgh contributed £833, Dundee £321, and Aberdeen £315. Glasgow, which was ultimately to surpass all three, paid £67. Berwick, after changing hands several times, had eventually become part of England. Various economic factors contributed to this change in Dundee's place in the national economy, but the strategic consideration was possibly more influential. Miss Grant has observed that Edinburgh was unduly vulnerable to attacks from England and that this resulted in a shift of the economic centre of gravity across the Forth. Dundee might be sacked from the sea, but a landward attack was

unlikely. The town was still predominantly a trading centre. The Gild Merchant, after centuries of shadowy existence, finally assumed an easily recognisable form in the early 16th century. But a new element, industry, had entered the town's economy. According to Warden, some, if not all, of the Nine Incorporated Trades existed in the 14th century, but there is no evidence of incorporation until the early 1500's. The mere fact of incorporation implies a more whole-hearted attention to industry as a full-time occupation, whilst the conflict between the craftsmen and merchants, settled by the " Decree Arbitral " of 1527, reveals the growing strength of the industrial element. This duality of the town's economy puzzled Bishop Leslie : " Neither sal ye weil discerne quither thay be richer in outlandis geir (foreign ware) and merchandise, or in thair awne labour and industrie."

The industrial life of the town was based on textiles. " Dunde," wrote Boece, " quhair mony virtewus and lauborius pepill ar in, making of claith." There was already some localisation of industry in Scotland, and by the end of the 16th century Dundee was importing more dye-stuffs than nearly all the other burghs put together. In the " Compt Buik " of the Dundee merchant, David Wedderburne, there are frequent references to the export of " hemp clayth," " narrow blew clayth," and " lyning," but the mainstay of the industry was plaiding. The plaid was the prevailing costume for men of all but the highest ranks, and women of all ranks enveloped their heads in plaiden shrouds whenever they appeared in public. Burghal edicts in places such as Aberdeen attempted to maintain the aristocratic character of the Scottish merchant class by forbidding the wearing of plaids and bonnets, but both Town House and pulpit thundered in vain against these popular garments, both of which were Dundee specialities. Nor was the demand entirely domestic. " Claythe and plading " represented nearly 40 per cent. of all exports of Scottish manufacturers in the early 17th century. Dundee was already importing some textile raw materials, hemp, and lint from the Baltic, though the wool was still home produced.

As the 16th century went on both the King and the Convention of Royal Burghs sought to stimulate this native cloth industry. Its development in Dundee was due less to this intervention than to the ease with which raw materials and finished goods could move along existing land and sea trade routes,* for Dundee still stood out as an importing and distributing centre, and the " Compt Buik " and Shipping Lists furnish a very complete picture of the trading activities of the burgh. As early as 1487 Aberdonians were deploring the fact that the Danzig traders had deserted them for Dundee and Leith. They might have added that the reason for this desertion was that Danzig merchants had been paid in spurious money at Aberdeen. By the latter part of the 16th century Dundee had twenty to thirty ships in the Baltic trade, the majority of them trading mainly at Danzig. With great regularity Dundee imported from the Baltic cargoes of timber, iron, pitch and tar, hemp and flax, and miscellaneous goods such as beer, wax, and copper-kettles. The large imports of timber bear out the early travellers' accounts of the treelessness of Scotland, and timber importers were often exempted from general trade restrictions. The import of Swedish iron should be read alongside the regular shipments of coal which came coastwise to Dundee. Together these indicate the existence of considerable smith-work.

*I have expounded this thesis more fully in Scot. Geog. Mag., Vol. 54, p. 345.

Whilst the town was well situated for the Baltic trade, this by no means monopolised the merchants' attention. Southwards Dundee traded with Flanders, France, Spain, and England. As for certuries before, a large part of this trade consisted of luxury goods, spices, wines, paper and toys, dates, onions, and " racket balls." There were some industrial raw materials, dye-stuffs from Dieppe and Bordeaux, bark (for tanning ?) from England, and, notwithstanding the large home production, salt. It appears that the salt from the pans alongside the Forth was unsuitable for fish curing, and with the development of fisheries in the eastern ports it became necessary to import a better quality.

The export trade still relied largely on the fruits of the land, the rivers, and the sea, for Dundee had consolidated its position as a collecting and distributing centre both for the neighbouring lowlands and for the Highlands. It shared with Perth the trade in Highland horses, coasting vessels brought down fish and butter from the Orkneys, and herring from the Hebrides. The manufactured goods exported consisted mainly of plaiding and other textiles. The Wedderburne " Compt Buik " throws much light on this side of Dundee's activities as well as on the commercial practices of the time. Occasionally a merchant sailed, but as a rule the skipper took charge as agent for the owners of the cargo. So in 1593 Wedderburne handed to Alexander Renkyne, skipper, 18 score and 10 ells of bleached linen, which he was to sell " quhair he hapnit to mak mercat." With the proceeds he was to buy gros-grained silk, if it could be got for 10 franks or less, and send it to Dundee by the first home-bound vessel. If such a purchase were impossible the money had to be lent on the best terms available. Then the shrewdness of the Scottish merchant becomes apparent. Peter Imrie, Wedderburne's relative, sailed on the same boat and received this injunction, " I pray you gif your counsell and attendance on Alexander Renkyn to sell my . . . lyning."

Scotland's trade in the early 17th century was still passing along channels cut three centuries earlier. According to Fynes Moryson the Scots had refrained from long voyages, not through lack of energy, but rather for want of capital. So far they had not joined in the scramble for colonial trade. When they did the whole economic centre of gravity of Scotland shifted westward. Dundee could neither resist this change nor yet participate in the profits immediately resulting from it. Her era of prosperity ended about the middle of the 17th century. In the Civil War, Monk captured the town—tradition has it that the garrison were " well drenched " in " large morning draughts of ale," slaughtered one-sixth of the inhabitants and took great plunder. " They gatt a very rich bootie ther," says John Lamont, " not onlie of the inhabitants, bot also of severall strangers. They gatte many ships in the harbery, nire by 200 veshells, great and small." Among this plunder was a store of cloth belonging to the factory at Newmills (Haddington). Soon after the harbour was destroyed by storm, and though a collection for its repair was taken in churches throughout the country, it remained ruinous and " choaked up with sand " until Defoe's time. The records of the Gild Merchant are consistently doleful : " the tounes low conditione," " ye decaying state of ye Burgh," a great many references to the town's creditors and ruinous houses, and from time to time the purchase of oatmeal from the north of Scotland for distribution among the destitute. To these local misfortunes must be added those acts of government which

affected the whole of Scotland. The temporary union with England (1654-60), the wars with Holland, and Colbert's protection in France all hampered Scotland's overseas trade. The monotonous reiteration of the Scottish merchants' grievances over the loss of ancient trading privileges indicates that the old commercial intimacy between Scotland and France was being destroyed even before the Union of 1707 imposed on Scotland the full weight of England's anti-Gallic prejudices. The Union, it is generally agreed, ruined the woollen industry, though by way of recompense it opened a " prodigious vent " for linens. Dundee had a small part in the Darien Scheme. The Gild Merchant, for example, invested £2,000 of its public stock, but the losses involved in this venture were a minor factor in the long depression. Dundee's prosperity came to an end forty years before the Darien Scheme, and it was not until the middle years of the 18th century that the town was able to reap any of the benefits of union with England. Between 1645 and 1695 Dundee fell from second to fourth among the leading Scottish towns. From 1650 to 1750 its population probably increased by about 50 per cent., reaching a total of 12,000 at the latter date, but in the next half-century alone it doubled. Its economic life continued sluggishly along lines already laid down. Raw materials from the hinterland were still prominent in the export trade, paving and mill-stones from the Carmyllie quarries to London and Holland, wheat and barley from Strathmore and the Carse of Gowrie to Dunkirk, Amsterdam, and London. Dofoe found that Dundonians had " a very large Correspondence with England," especially in corn and linen. He noted the extensive grain-granaries by the Tay, and found that rents on the Carse were paid in kind and the landlords disposed of their stocks through Dundee grain merchants. In the staple textile industry there was a tendency to abandon the woollen branch, plaiding and bonnets, in favour of linen. Thread-making, according to Defoe, was a " famous " Dundee industry, but apart from this Dundee already concentrated mainly on the coarser end of the linen industry. The home-grown flax was roughly treated in the preliminary stages by local growers and thus unfit for the finer yarns. The imported flax, from Riga and Petersburg, was regarded by contemporaries as much poorer in quality than that grown in Britain. And as early as 1735 linen from Dundee and district was being sent to London for shipment to the American colonies, the great market for coarse linens.

When, by the second half of the 18th century, prosperity was again lapping against the walls of Dundee, the manufacture of coarse linens was the staple occupation. By the 1770's David Loch could speak of Dundee as large, prosperous, and " greatly increased within these twenty years, and still continues to be enlarged." Of the factors responsible for this vitality some were peculiar to Dundee, others common to the whole of Scotland. The Board of Trustees, established in 1727, lost no time in encouraging the making of coarse linen suitable for the Plantation market, where, owing to the " drawback " system, German Osnaburghs and Silesias occupied a favoured position. By the 1740's they could report that the making of Osnaburghs had commenced in Dundee and Arbroath. Already by 1741 the quantity of linen stamped had risen to nearly five million yards, more than double the 1728 figure, and under pressure from manufacturers parliament introduced a policy of subsidizing exports which was maintained with slight breaks down to 1832. The bounty rates as fixed in 1745 were :—

Linen worth under 5d. per yard.		bounty	½d. per yard.
,, ,,	over 5d. and under 6d.	,,	1d. ,,
,, ,,	,, 6d. and ,, 1/6d.	,,	1½d. ,,

The average price of all linen stamped in Scotland in 1727-8 was 11d., in 1738 9½d., and in 1748 just over 9½d. The average prices in these years for Forfarshire linen were just under 6d., 5¾d., and nearly 6¼d. In other words, the makers of course linen received as great, or almost as great, a subsidy as those, for example, in Lanark, who made linen of considerably higher value. The bounty system was thus weighted in favour of the coarser end of the trade.

The Jacobite rising of 1745 produced two salutory effects for Dundee. The first was the movement, initiated by various notable persons, for the establishment of a company to promote the linen industry, especially the export of linens to America and Africa. By 1766, according to Postlethwayt, this British Linen Company had considerable stocks of Osnaburghs in London ready for shipment to America and the West Indies. The second beneficial result of the '45 was the abolition of hereditary jurisdictions. The effect was perhaps psychological rather than directly economic, but as Warden says, with the expropriation of the rights of the Duke of Douglas, " the town began to emerge out of the gloom in which it had so long been shrouded."

So when the second half of the 18th century opened Dundee's fortunes were rising. Her place in the linen trade was clearly established, though the industry was widely dispersed through the neighbouring districts. Both spinning and weaving were still in the domestic stage, and the entrepreneur, the capitalist merchant, was an essential link in the organisation. The efforts of official and semi-official enterprise, and the dislocation of the competitive industry on the Continent by the Seven Years' War, all worked to her advantage. But whilst linen had replaced woollens as the main article of manufacture and export, it by no means monopolised the energies of the town. The commercial life and shipping never really recovered from the destruction of shipping and property in 1651 and suffered from the westward shift of Scotland's commercial life, but at the end of our period, in 1759, the author of the " Universal Geographical Dictionary " could write " Dundee is one of the best ports for trade in all Scotland, particularly for foreign, yet it has considerable inland business also, especially for corn and linen cloth." For the economic history of Dundee reveals no abrupt changes, but a very faithful adherence to tradition.

2.—THE DEVELOPMENT OF THE LINEN AND JUTE INDUSTRIES FROM THE DOMESTIC SYSTEM TO THE GREAT WAR

BY

DENNIS CHAPMAN, B.Sc.(Econ.).

Introduction.

This paper, which covers the period of the industrial revolution for the coarse linen industry of Dundee and the establishment and the great expansion of the jute industry, will seek to explain both the reasons for the establishment of the jute industry in Dundee and the emergence of Dundee as a single industry town. It will be necessary to concentrate attention mainly upon the textile industry, but some mention will be made of the whale fishing and the shipbuilding industries. It is obvious that, in an article of this length, it will not be possible to treat the more human aspects of industrial development that are comprised under the heading of " Life and Labour." It is, however, hoped to break some new ground by drawing attention to the work of the Brown Family, who undoubtedly played a decisive part in the transformation of the industry in the period of the industrial revolution.

Part I.

The Industrial Revolution and the Establishment of Jute.

The situation of Dundee as the port for Angus, whose chief industry depended on an imported raw material, Baltic flax, and whose production was almost entirely for export, led naturally to its development as a merchant centre. The founding of the Dundee Banking Company in 1765 by George Dempster was important in that it made available the capital necessary for the expansion which came first of all in the industry on a domestic and later on a factory basis. There was, however, little development of Dundee as a manufacturing centre owing to the almost complete absence of water power ; indeed, water was so scarce as to make it difficult to run steam engines. Wm. Brown, writing in 1816, records that an important disadvantage of Dundee was that water was " scanty " and of a " quality hurtful to boilers." There were attempts to establish steam-driven spinning mills in Dundee after 1793, but the first successful mill appears to have been started in 1798 by George Wilkie with a 20 horse power Watt engine. By 1800 there were 5 mills with some 60 h.p. between them.

The Brown Family Pioneers of Mill Spinning.

Until 1806 no progress was made ; in this year, however, James Brown built the Bell Mill, which was to be the model of all subsequent ventures for the next 20 years. It was of fireproof construction and had the latest machinery from Leeds. It appears that James Brown had considered building the mill

for cotton, and in his deliberations he had sent his son William Brown to study the linen industry in England, where the latter visited Porthouse, the co-inventor with Kendrick of the flax spinning frame.

Just as his father had effected considerable improvements in mill construction, so William Brown made improvements in technique which were to be the model for the first great advance that the industry made between 1825 and 1826. In 1809 he took over George Wilkie's mill, which was in a ruinous condition, and reorganised it, by 1811 it was working, and he then commenced a long series of experiments in the many branches of mill spinning. He kept manuscript records of these experiments, which covered such topics as labour management, on which his views were remarkably modern, mill sanitation, fire drill, steam engines, spinning frames and, in particular, the carding of tow. Some measure of his success may be made from the fact that between 1813 and 1816 he doubled his putput and at the same time reduced its cost from 10d. per spindle to 6d. per spindle. His attention was directed mainly to developing the spinning of tow, the waste produced when flax was dressed, and so well did he succeed that by 1819 he could write that " Tow yarn of 6/6 per spindle now almost superseded flax yarn of the same weight, and cloth made from it in many cases passed without being known."*

This perfection of tow spinning was important, because it was the beginning of the tendency towards the utilisation of cheaper fibres and because the processes of preparation, particularly carding, were adapted at a later date for jute.

The Introduction of Jute.

According to the traditional theory, the presence of ample supplies of cheap whale oil necessary to soften the fibre before spinning was the deciding factor in the establishment of the jute industry in Dundee. It appears, however, that the Linen centres of Aberdeen, Inverness, Kirkcaldy, Belfast, and Leeds—through the port of Hull—all had easy access to whale oil, which was at that time the universal illuminant. It is therefore necessary to seek some further explanation. This is to be found in the differences between the various kinds of linen produced in the different centres : Dundee alone had a large trade in the particularly coarse baggings made of hemp and coarse tow which were used for the packing of cotton wool, and it was in the production of these that jute was first employed.

The development of tow spinning was the first stage in the utilisation of cheaper fibres, it was followed in 1816 by the introduction of Sunn hemp —again in the coarest end of the trade.

From 1826 to 1835 was a period during which, in years of bad trade, there were many experiments with jute, but the fibre was not really established until the slump period after 1836. This was the result of the coincidence of many factors. On the technical side there was the invention of batching—the softening of the fibre with a mixture of oil and water ; this appears to have been a modification of hemp technique. On the economic side there appear to have been the following factors :—

*I should like to acknowledge the assistance of Mr J. Norman Methven, who very kindly gave me access to the manuscripts on which this section is based.

1. The origin and nature of the slump.
2. Indian competition.
3. The establishment of a market for jute products.
4. Direct trade with India.
5. The fear of the interruption of supplies of flax and hemp.

1. *The origin and nature of the slump.*—The immediately precipitating factor appears to have been a vast over-production of hemp bagging for cotton wool. In 1834 there had been a boom in this particular commodity, and in 1835 there had been a large warehouse fire in New York which had destroyed much of the American stock of bagging. Hemp prices were low, and there appeared to be possibilities of considerable profit. The result was considerable over-production, and the price of bagging fell from 7½d. a yard in 1835 to 5½d. a yard in 1837, whilst at the same time the price of hemp rose from about £25 per ton to £41. These conditions made it necessary for cheaper raw materials to be used if the trade was to continue.

2. *Indian Competition.*—This was an entirely new factor which appeared in this same market. The following report from the Dundee *Advertiser* of May 17, 1839, illustrates the situation: "It appears that the customs house at Philadelphia are admitting a species of gunny bagging from the East Indies, duty free, which is likely to totally supersede the cotton bagging (hemp bagging for cotton) from Britain, on which there is a duty of nearly 2d. per yard.

3. *The establishment of a market for Jute products.*—A Mr Rowan, who in 1833 had experimented with jute, had for long supplied the Dutch Government with tow yarn for coffee bags. In 1838 he persuaded them to use jute yarns.

4. *Direct Trade with India.*—In May 1839, Dundee obtained the privilege of direct trade with India, which brought about a saving of 17 shillings a ton on jute.

5. *The fear of the interruption of Flax supplies.*—This fear had been present in the minds of the Dundee merchants since the period of the Napoleonic Wars, and when in 1838 it was feared that there might be a war with Russia arising out of the tension of the first Afghan War, the Dundee press devoted much attention to possible new sources of raw material.

These factors brought about the considerable use of jute, as a substitute for hemp and tow, and as an adulterant of tow in the coarsest fabrics. It was not until 1848, however, again in a period of depression, that James Aytown of Kirkcaldy, a spinner who had done much to perfect tow spinning, conducted experiments which enabled Jute yarns to be woven without sizing. This enabled the use of the fibre to be greatly extended.

TABLE I.

TOTAL IMPORTS OF FIBRE INTO DUNDEE.

1796 to 1850.

Year.		Tons.	Year.		Tons.
1796	....	3,336	1835	....	27,130
1815	....	2,187	1840	....	27,980
1820	....	4,958	1845	....	41,944
1825	....	13,902	1850	....	55,718
1830	....	20,496			

We may now sum up the development of the industry to 1850, which made possible the great expansion of the Crimean and American Civil War periods. There appears to have been little quantitative expansion in the industry until after 1816, when for the first time total fibre imports were greater than those of 1796, although the considerable technical advances had been made.

There was a very considerable expansion between 1816 and 1826, followed by a period of steady progress until the violent increase of the boom year of 1836. In the slump which followed, jute was successfully introduced, and it soon almost completely replaced hemp, and was widely used with tow in many of the coarser fabrics.

Part II.

The Economic Development of the Jute Industry, 1850 to 1918.

The successful establishment of jute manufacture has already been described ; this section will trace the further development of the industry with special reference to the present situation and to the emergence of Dundee as a single industry town.

1. The Perfection of Technique and Organisation.

There remains one important improvement in technique which came before the expansion of the Crimean War period : this was Worral's wood clothed card. The new jute industry had taken over the carding machine, which had been used for tow preparation. This had an arrangement of steel staples drawn through leather as a means of combing or carding the fibre. The coarse and dirty jute fibre quickly destroyed this " card clothing " and necessitated repairs which were both slow and expensive. Worral's improvement consisted in replacing the leather with hardwood staves into which tempered steel pins were inserted. The new card, which was more efficient, more durable, and easily repaired, came into general use shortly after its invention in 1853. This was followed in 1857 by a great advance in the organisation of plant in the Bow Bridge Works, which set the pattern for the great expansion which followed the American Civil War in the same way as James Brown had done some 50 years earlier.

2. The Influence of War Demand.

Warden has summarised the effects of the Crimean War as follows :— " During the Crimean War an immense demand sprang up for coarse linens, and the manufactures of Dundee were largely consumed by both belligerents during the siege of Sebastopol. The profits thus realised stimulated enterprise, and led to the erection of extensive new works for spinning and weaving by power and great additions to previous ones."* Dundee had imported record quantities of flax in preparation for the war, which threatened to cut off supplies, and during the war, when flax imports declined, jute imports increased and became as important as those of flax.

Following the depression of 1857 Dundee trade developed slowly until the second year of the American Civil War. The shortage of cotton increased

*Warden, A. J. *Linen Trade* (London, 1864), p. 618.

†Boase, C. W. 1867. *A Century of Banking in Dundee.* Edinburgh, Grant & Son. p. 505.

the demand for linens, whilst at the same time both armies were using very large quantities of the coarse products of Dundee. Much of the profit of this trade was devoted to the expansion of the industry, many firms building calenders, whilst two firms, Messrs Cox and Messrs Grimond, bought clipper ships to bring jute direct from Calcutta. The extent of the expansion can be measured by the increase in the total imports of fibre—from 75,000 in 1863 to 91,000 tons in 1864 and 116,500 in 1865. Warden estimated the value of the annual product of the industry as 5 million pounds in 1864 and 8 million pounds in 1867, which may be compared with the estimate of 3½ million pounds made by the manager of the Dundee Banking Company in 1857.†

3. The Great Jute Expansion.

After the end of the American Civil War there was a short period of bad trade, but the next few years were to be the most profitable in the history of Dundee.

The Calcutta industry had been established, but its growth, so far, had been largely at the expense of native production. The continental industry was as yet insignificant. Dundee thus had an almost complete monopoly.

At the same time there was an enormous growth in demand resulting from the opening up of the American West by railways ; the increase of American agriculture and the Franco-Prussian War. At this time about one-half of Dundee's production was going to America. By 1871 the import of jute into Dundee passed 100,000 tons, and by 1873 the peak of the boom was reached with an import of over 140,000 tons.

The extension of plant was of an entirely different order, by 1874 the number of spindles being almost doubled and the number of looms and operatives more than doubled in comparison with 1870. (These returns relate to Scotland, but in practice the jute industry was almost confined to Dundee.)

Table II.

Growth of the Scottish Jute Industry.

Year.	Spindles.	Looms.	Persons Employed.
1870	94,520	3,744	14,911
1874	185,419	8,325	37,920
1878	183,056	10,009	30,401
1885	225,399	10,856	36,269
1890*	268,165	14,107	43,366
1905*	263,938	13,704	40,861†

*Returns for U.K. †Return for 1904.

4. Competition and Tariffs.

The development of the Calcutta industry had the effect of limiting the growth of the Dundee industry, but did not endanger it until much later, because for long there was a large demand for types of fabrics which could not be produced by the less skilled native labour. The rate of development of Calcutta was very rapid, especially between 1865 and 1875, when the number of spindles increased from 12,000 to 59,500. This increase continued until 1894, after which there were enormous and spectacular increases.

Competition from Calcutta rapidly ousted Dundee from the coarse market, and by 1886 Dundee had lost her markets of Australia, the Cape, and the San Francisco market for grain bags. The period after 1880 was marked by the imposition of tariffs which very considerably reduced Dundee's trade with the Continent. By 1886 Austria, France, Germany, Italy, Russia, Spain, and U.S.A. had imposed heavy tariffs on various categories of jute imports.

5. Investment out of Jute.

The effect of this new competition, together with the partial exclusion of Dundee from many of her markets by tariffs, explains why the equipment of the industry did not expand greatly after 1874 (Table II.), although it will be seen from the figures of Jute Imports (Table III.) that the consumption of Jute doubled in the later years of the century. A consideration of a number of other factors will go some way towards explaining why no other considerable industry was established in the area.

Table III.

Imports into Dundee, Tons.

Year.	Jute.	Flax.	Tow.
1850	14,080	31,572	8,962
1855	25,894	23,018	5,112
1860	36,965	23,801	4,455
1865	71,702	36,147	6,624
1871	102,844	39,361	11,544
1875	113,930	22,572	6,500
1880	103,423	29,979	8,387
1885	175,688	28,451	4,800
1890	238,884	24,230	4,888
1895	277,315	24,551	5,124

It is likely that the expansion of the industry in the period before 1874 was greater than was profitable, so that it was to be expected that Dundee's investments after this date would be directed to other channels. Important factors in the direction of this investment were the geographical isolation of the area from internal markets, the lack of coal and iron in the district, and the relatively unproductive nature of the hinterland, much of which was sporting estate. In connection with the factor of isolation, it must be remembered that the first Tay Bridge was not opened until 1878, and was destroyed in the same year and not reopened until 1887. The Forth Bridge, which was also important to Dundee, was not opened until 1890.

It is, therefore, not surprising that Dundee's investment was not to any great extent devoted to new projects in the locality. On the other hand, the intimate relations with the U.S.A. which had developed from the very important trade which the city had in Jute and Linens with that country had much to do with the formation after 1879 of the prudent Scottish American Investment Trusts and the more speculative ventures into land and cattle companies and railways. Dundee also had investments in Australia, Canada, Ceylon, New Zealand, and Hawaii. To this period belongs the formation of the two new Dundee Calcutta Jute Companies—the Victoria and the Titaghur—founded in 1884.

The Pre-War Jute Industry and the Decline of Linen, Shipbuilding, and Whaling.

As has been seen from Table II., there was no great increase in the size of the industry after 1874; it was, however, fairly prosperous, and, as will be seen from the imports of jute, Table IV., had reached a position of relative stability in the pre-war years. It seems likely that to some extent Dundee's position was dependent on the various measures of restriction of output which were employed by Calcutta in one form or another during most of the period from 1886 to 1912.

Table IV.

Jute Imports Retained for Consumption in U.K.

	Tons.
1900	172,981
1901	199,366
1902	291,853
1903	159,507
1904	203,177
1905	226,675
1906	230,936
1907	225,413
1908	249,175
1909	199,429
1910	201,490
1911	190,302
1912	244,588
1913	220,995
1914	158,035

The position of linen was not so satisfactory. By 1886 the import of flax was only about a half of what it had been in the boom years of the American Civil War, and there were only three firms left in the town which specialised in flax, and these were very largely dependent on government contracts. This decline continued except for a peak in 1895, until a low level of only 13,390 tons was reached in 1910. This may be accounted for partly by the reduction in the tonnage of sailing ships, which declined from nearly 4,000,000 tons in 1880 to just under 800,000 tons in 1914.

Competition from mineral oil, together with increasing difficulties in the Arctic fishing, caused the almost complete extinction of the Dundee Whaling fleet by 1914.

The position in shipbuilding was similar: the latter years of the 19th century saw four firms close down, leaving four firms working in 1900. In 1908 one of the largest of these closed down, and in 1912 yet another, so that whereas the gross tonnage launched in Dundee between 1905 and 1908 averaged 22,000 tons, the output in 1909 was only 8,000 tons and in 1910 6,000 tons.

Summary and Conclusion. Dundee as a Single Industry Town.

The decline in Dundee's subsidiary industries had made the city more dependent on the jute industry in the immediate pre-war period than it had ever been before. At the same time it seems that the prosperity of Dundee

was to a considerable degree dependent upon the policy of restriction in Calcutta. It appears unlikely that Dundee was better equipped than its rival; indeed one observer writing in 1913 stated that in size, lay-out, and equipment the Scottish industry was behind that of Calcutta.*

The outbreak of the Great War, therefore, came at a time when the jute industry was in very weak competitive position. During the war Dundee had a period of prosperity, hampered occasionally by shortage of raw material. This had the effect of giving a very considerable new lease of life to plant, much of which was already obsolete. The Calcutta industry increased in size during the war and gained positions in markets that Dundee was forced to neglect.

The position of the city and its main industry at the end of the war was as follows. Owing to the concentration on war-time needs there had been no replacement of the important subsidiary industries of whale fishing, linen, and shipbuilding. The Jute industry which had been in a weak position in 1914 found that it had to face even greater competition from India than before with plant that had not been replaced during the war period.

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*Clark, W. A. G. (1913). *Linen, Jute, and Hemp Industries in the United Kingdom.* Special Agents Series, No. 74. Washington Government Printing Office. p. 106.

3.—THE INVESTMENT TRUSTS IN DUNDEE

BY

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Dundee is sometimes referred to as the home of the investment trust movement. The success of the Scottish American Investment Trust, established in Dundee in 1873, and the prominent part taken by its founder, Robert Fleming, in the whole movement, were of great importance in the development of investment trust finance.

Robert Fleming visited the United States in 1870 on behalf of his principal, Edward Baxter, who had large interests in American securities. He returned to Dundee greatly impressed with the importance of that country as a field for the investment of British capital. At this time the jute industry was very prosperous and Dundee had capital available for foreign investment. Fleming was able to impress financial men in Dundee with the advantages of the United States as a field for investment, and in February 1873 the Scottish American Investment Trust was formed. The First Issue of £300,000 was made in this year. The Scottish American Investment Trust (First Issue) was to terminate at the end of ten years, when the investments were to be realised and the proceeds divided *pro rata* among the holders of unredeemed certificates. The issue had been made in the form of bearer certificates of £100 each. The capital was invested mainly in United States railroad

mortgage bonds, which were carefully selected. The annual income from the investments, after payment of management expenses, was fully 7 per cent., so that a large surplus was left after payment of the interest at the fixed rate of 6 per cent. on the trust certificates. It is interesting to note that John Guild, the chairman, enunciated one of the fundamental principles of investment trust finance at the first general meeting of the Trust : " Perhaps the chief advantage of the Trust is the distribution of risk which it so simply accomplishes. A holder of a single £100 certificate has an interest in thirty different carefully-selected bonds ; not more than £7 of this capital is placed in one security in any case, and on an average not much more than £3 of the £100 certificate is placed in any one investment."

The first year of the Trust's operations was a difficult one. When the investment of the £300,000 capital was almost completed, a severe panic developed in the United States. Robert Fleming, who was secretary to the Trust, confessed that the 1873 panic invaded his dreams. The First Issue, however, weathered the panic, and did well during the difficult slump years which lasted until 1879.

Robert Fleming and his associates early began to expand their operations. In the Trust's first year a Second Issue of trust certificates, amounting to £400,000, was made. This issue was subscribed just before the panic, and was invested after the panic when the prices of bonds were low. The funds of the Second Issue were also invested mainly in mortgage bonds of United States railroads, and the average amount of each investment was considerably less than one-fiftieth of the capital.

A Third Issue, amounting to £400,000, was made in 1875. This issue brought the total amount of capital controlled by the Scottish American Investment Trust up to the large amount of £1,100,000. The three issues of certificates made by the Trust proved to be very remunerative investments in the difficult seventies. Six per cent. interest was paid annually on the certificates of all three issues and large reserve funds were accumulated. In 1879, for legal reasons, the Scottish American Investment Trust, with its three issues of certificates, was on March the 24th registered as three distinct companies under the Joint Stock Companies Acts. These companies were the First, Second, and Third Scottish American Trust Companies. The trustees were able to point out at this time that " The Scottish American Investment Trusts were never in so prosperous a condition as they are at the present time. At present market values of the Assets of the Trusts the New Companies will start with a Reserve Fund in the aggregate of over a Quarter of a Million Pounds sterling, and with a net Revenue of between Eight and Nine per cent. per annum."

For thirty years, until 1910, the capital of the three Scottish American Trust Companies consisted entirely of ordinary stock. No preference stock or debentures were issued, in contrast to the Dundee land trust companies. Good, steady dividends were paid by all three companies, although the period included both good and bad years. During these thirty years the First Company paid regular dividends of from 8 to $8\frac{3}{8}$ per cent., slightly over $8\frac{1}{4}$ per cent. on the average. The Second Company paid regular dividends of from 8 to $8\frac{1}{2}$ per cent., and the Third Company of from $7\frac{1}{2}$ to $7\frac{3}{4}$ per cent. The somewhat lower dividend of the Third Company was due to the fact that its capital had originally been invested at a less favourable time. The

prices of United States railroad bonds were higher in 1875 than in 1873. The Companies pursued a conservative policy of building up large reserve funds, and they were able to pay steady dividends by maintaining a good margin between earnings and dividends in good years, which could be narrowed during a depression.

The great success of the Scottish American Trust Companies stimulated the directors to form a sister company in 1896, the Northern American Trust Company, Ltd. The investment powers of the new Company were much wider than those of the old Companies, being universal, general powers, but the prospectus stated that it was intended to invest the great bulk of the share and debenture capital in " bonds of railroads and other corporations and undertakings in the United States, including States or Municipalities, but chiefly in the mortgage bonds of railroads there." The Northern American Trust started with a paid-up capital of £300,000. The more modern capital structure was adopted for this Company ; the capital was arranged in the proportion of 60 per cent. in 4 per cent. preferred stock to 40 per cent. in ordinary stock, and a limit of 100 per cent. of the total capital was imposed on the issue of debenture stock. During the Company's first year £300,000 of 3½ per cent. debenture stock was issued, and its borrowing power was thus temporarily exhausted.

A policy of capital expansion was pursued on behalf of the Northern American Trust in its early years. By 1908 its total capital had been raised to £1,000,000, and its debenture debt to the same amount. The debenture debt was now in two forms ; debenture stock of £750,000 and terminable debentures of £250,000. The figures for capital and debenture debt remained unchanged until 1924, apart from small changes in the amount of terminable debentures. The expansion of the Northern American Trust was stimulated by its great success. From 1897 to 1914 the dividend was raised by one per cent. every two years from 5 per cent. to 13 per cent. A large reserve fund was also accumulated.

The excellent results of the Northern American Trust caused the directors to make important changes in 1910 in the conduct of the sister Companies, the three Scottish American Trust Companies. The powers of investment were extended and provision was made for the issue of debenture stock. Up to 1910 investments had been mainly restricted to bonds of railroads in the United States, but now they were made in a wider field. The wider powers of investment were, however, used only moderately, and in 1912 the investments still remained to a preponderant extent in the United States. The new borrowing powers were fully used, and by 1911 the three Companies had all issued debenture stocks. Dividends now increased, and by 1914 the First, Second, and Third Companies were paying dividends of 9⅜, 9½, and 8¾ per cent. respectively.

In 1913 the Camperdown Trust Company, Ltd., was formed, having as its London correspondent Robert Fleming & Co. This Company started with a capital of £300,000.

The land mortgage companies, which were developed about the same time as the Fleming Companies, formed a second group of trust companies in Dundee. The Alliance Trust Company, Ltd., which is now the largest investment trust in Europe, was formed in 1888, but its history can be traced back to 1873, the same year as the foundation of the Scottish American

Investment Trust. The Alliance Trust had its origin in the Oregon and Washington Trust Investment Company, Ltd., which was promoted by William Reid to invest in land mortgages. In 1874 William Mackenzie, who created the Alliance Trust by his policy of amalgamations, was appointed secretary to the Oregon Trust. The Trust invested in mortgage loans in the State of Oregon and Territory of Washington, and derived great advantage from the high rates of interest at this time. The mortgage loan rate was 12 per cent. in 1877 and 10 per cent. in 1878. From the start the practice of raising part of the funds for investment in mortgage loans by borrowing on debentures was followed. By 1878 the Company's capital amounted to £50,000 and its borrowed money to £132,046. The Trust was very successful and paid good dividends.

The directors of the Oregon Trust promoted in 1876 the Dundee Mortgage and Trust Investment Company, Ltd. William Mackenzie was also secretary of this Company. The chief objects of the new company, like those of the old, were to borrow money at a comparatively low rate of interest and to lend its paid-up capital and borrowed money on mortgages abroad. Unlike the Oregon Trust, however, the Dundee Mortgage Company was permitted to invest anywhere in the United States and the British Empire. Further, the securities of the new Company were not to be confined to mortgages over lands and other real property, although they were to form the chief and favoured class. In 1879 the Company had a capital of £70,000 and borrowed money amounting to £285,341. Mortgages over real estate in the United States and Canada amounted to £318,187. The Dundee Mortgage Company was able to pay very satisfactory dividends from the beginning.

In 1879 William Mackenzie began his policy of amalgamations by combining the Oregon Trust and the Dundee Mortgage Company. The Dundee Mortgage Company was now an important Company, and in 1880 it had a capital of £118,000 and debentures amounting to £489,881. William Mackenzie proceeded with his policy of amalgamations in 1882, when the Oregon and Washington Mortgage Savings Bank Company, Ltd., was amalgamated with the Dundee Mortgage Company. Mackenzie had become secretary to the Savings Bank in the previous year. It had been promoted by William Reid in 1876 with the main objects of accepting savings deposits in Oregon, borrowing money on debentures in Scotland, and investing its funds in first mortgages over land in Oregon and Washington. The operations of the Savings Bank were always on a small scale, but satisfactory dividends were paid.

The Dundee Mortgage Company felt the great and general depression in the United States and Canada in 1883, when the prices of agricultural products fell to very low levels. The Company was, however, in a strong position, having pursued a conservative reserve fund policy in the past, and the usual dividend of 10 per cent. was maintained up to the amalgamation which created the Alliance Trust.

In 1889 the Dundee Mortgage Company and the Dundee Investment Company were amalgamated to form the Alliance Trust. The Dundee Investment Company had its origin in the Dundee Land Investment Company which was formed in 1878. It was promoted by several gentlemen connected with the Dundee Mortgage Company, and William Mackenzie was its first

secretary. It was essentially a company for speculating in land, the chief object being to buy land and hold it until it could be sold at a high price. By 1881 the Company held real estate in the United States and Canada amounting to £101,577. In 1882 it was reconstituted as the Dundee Investment Company, Ltd., and its policy was completely changed. The speculative policy of purchasing land was given up and the real estate held was liquidated as quickly as possible. The Dundee Investment Company, like the Dundee Mortgage Company, invested mainly in mortgages over real estate.

William Mackenzie's policy of amalgamation culminated in the combination of the Dundee Mortgage Company and the Dundee Investment Company to form the Alliance Trust Company, Ltd. The Alliance Trust was registered on April the 21st, 1888, and took over the business of the two amalgamated companies on November the 1st, 1889. The Alliance Trust was a wealthy company from the start, controlling a total amount of funds in the form of capital, reserves, debentures, and temporary loans of over one and a quarter million pounds. It was definitely a land mortgage company, but even in 1890 the percentage of total funds invested in the mortgage field was only 86·89 owing to the policy of investing reserves in bonds.

The acute agricultural depression which followed the panic of 1893 provided a severe test for the trusts operating in the mortgage field. During these difficult years the Company's revenue suffered, and in 1895 the dividend was reduced from 12½ to 10 per cent. In 1896 the dividend was further reduced to 8 per cent., at which rate it remained until 1905.

There was a large expansion of the capital of the Alliance Trust during the years from 1890 to 1914. By January the 31st, 1915, the Company's capital amounted to £1,500,000, and it had a reserve fund of £800,000. Debentures and interim loans now amounted to £2,205,765. After 1905 there followed a period of rising dividends. In 1906 the dividend was raised to 10 per cent. and by 1915 it had risen to 19 per cent.

Another land mortgage company in Dundee was the Western and Hawaiian Investment Company, Ltd., which was formed in 1883, and which was renamed the Second Alliance Trust Company, Ltd., in 1923. This Company dates back to 1880, when the Hawaiian Investment and Agency Company, Ltd., was formed. The Agency Company was formed to make mortgage loans in the Hawaiian Islands. The Western and Hawaiian Company, which took over the Agency Company's business in 1883, invested mainly in North America. It was entirely a land mortgage company before the War, and even in 1918 81·8 per cent. of its total funds was invested in the mortgage field. By 1915 this Company controlled a total amount of funds amounting to £603,713.

The British Canadian Trust, Ltd., which was registered in 1910, was the last land mortgage company to be formed in Dundee. In 1914 77 per cent. of its total investments was in the form of mortgages over real estate in North America. At this time the Company controlled total funds amounting to £523,922.

The Dundee Trusts did not, of course, expand their operations during the War. Their earnings were, however, fairly well maintained ; no company reduced its dividend, and the Alliance Trust actually increased its dividend

in 1915. Since the War only one new investment trust has been formed, but the capital and debenture debt of some of the old trusts have been greatly expanded. The Dundee and London Investment Trust was formed in 1927, and is independent, like the British Canadian Trust, of the Alliance group and of the group consisting of the three Scottish American Trusts and the Northern American Trust. In 1938 the Dundee and London Trust controlled total funds amounting to £871,245. The Alliance Trust's policy of increasing its capital began in 1921, and total capital amounted to £3,250,000 in 1934, since when there has been no further increase. In 1938 the Company's debenture debt amounted to £5,769,665 and total investments to £11,623,420. The policy of expansion was also applied to the Second Alliance Trust, which had been called the Western and Hawaiian Investment Company until 1923. The management of this Company had been transferred to the office of the Alliance Trust in 1918. The capital and debenture debt of the Second Alliance was increased so that by 1938 its investments amounted to £3,923,003. The three Scottish American Companies split their capitals into ordinary and preference stock in 1928, and at about this time each of the Companies increased its capital by £100,000. In 1938 the total investments of the three Companies amounted to £4,800,005. The Northern American Trust increased its capital in 1924 and in 1925, since when it has remained unaltered. In 1938 its total investments amounted to £4,273,010. The Camperdown Trust showed increases in its capital in 1921 and in 1928. In 1938 its total investments amounted to £1,672,933.

Further important developments in the conduct of Dundee's trusts must be noted. The companies which were interested in the mortgage field have been gradually eliminating their mortgage business and devoting all their funds to general investment. In 1937 the Alliance Trust had only 7·8 per cent. of its funds still in the mortgage field. All the companies have reduced the percentage of their investments located in the United States. This policy was initiated in the pre-War years, and was accentuated during the War when the British Government required American credits. A further change in the investment lists has been a decline in the importance of bonds relative to preference and ordinary shares. There has also been an important change with regard to debenture debt. The English investment trusts have never issued terminable debentures for short periods, while the Scottish trusts have made extensive use of this method of borrowing. Indeed, the Alliance Trust had issued no debenture stock until 1925. A more conservative policy in this respect was now adopted, and by 1936 the Alliance Trust had a larger amount of debenture stock than debentures and short loans.

The financial results achieved by the Dundee trusts were most satisfactory up to about 1932 and dividends were greatly increased. There followed a period of falling dividends due to the effects of world depression. Dividends rose again as a result of economic recovery, but only the Alliance Trust has been able to restore its maximum rate of dividend. The Second Alliance and the British Canadian Trust paid in 1938 dividends only one per cent. lower than their maximum rates. The high level of dividends paid by the Dundee trusts is the result of a high ratio of debenture debt and preference stock to ordinary capital and of the accumulation of large reserve funds in the past.

The accompanying table shows the progress of Dundee's investment trusts :—

Year.	Total Investments (Book Values).
1880	£1,972,736
1890	2,751,380
1900	4,113,540
1914	10,802,567
1920	11,201,646
1930	23,827,650
1938	27,869,450

X.

AN ECONOMIC SURVEY OF PRESENT-DAY DUNDEE

BY

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Industry and Trade of Dundee.

Dundee is a single industry town and the British jute industry is almost wholly located in Dundee. These two facts must form the starting point for any economic or social study of the city. The problems of the jute industry are the problems of Dundee, for not only is that industry the principal employer of labour, but most of the rest of the town gets its living in industries subsidiary to it or by catering for the personal needs of those employed in it.

The population Census of 1931 records 95,175 persons in the city as gainfully occupied, and of these almost 34,000 described themselves as attached to the jute industry. Despite the shrinkage which has taken place during the past eight years, jute remains by far the largest employer of labour, and of almost 72,000 persons in the city registered under the Unemployment Insurance Acts in July 1938, nearly 26,000 were employed in that industry. The intense localisation of the industry is shown by the fact that there are little more than 4,000 persons outside the city employed in it. Apart from the distributive trades, which employ some 10,000 insured persons, all other industrial groups number less than 3,000, and of these general engineering, which is largely textile engineering, and bleaching and dyeing are mainly dependent on the jute industry. Of the rest only linen, printing and publishing, and shipbuilding are catering for an extra-local market.

The coarser types of flax and hemp goods are manufactured in Dundee by a few survivors of the industry, which once provided much of the sailcloth for British shipping and was the parent of the jute industry. There are, indeed, several very old jute firms which were originally founded as linen manufacturers. This industry has benefitted greatly in recent years from the rearmament demands for tenting, sailcloth and other heavy linen for naval and military equipment. There are also one or two firms making fine linens or fabrics of linen mixtures. Of these products Glamis furnishing fabrics enjoy an international reputation for excellence of design.

There are also a few small but prosperous industries in which relatively high transport costs are not a severe handicap. Every member of the Association who purchases post card photographs of Scottish scenery makes the acquaintance of the products of Messrs Valentine, art publishers of Dundee. The Leng Thomson Press publishes morning and evening papers with a wide circulation in East Scotland and also numerous magazines and weeklies with a national circulation. The firm departs from normal practice by employing

a staff of between 70 and 80 artists to produce illustrations instead of purchasing the work of free-lance illustrators. The Press has in the past been a nursery for budding journalists which has provided Fleet Street with some prominent figures.

The product most commonly associated with Dundee by people from south of the Border is marmalade, but the numbers employed are not large. Even when those engaged in the canning of fruit, vegetables, and fish and in cocoa and sugar confectionery are included, the total is merely a normal figure for a town with a population of 180,000. Several canneries have been established in Angus in recent years by English firms who wished to take advantage of the particularly good canning qualities of the local raspberry crop. But as the season lasts only a few weeks, it has been necessary to find other products to fill out the year, and in some cases production has been transferred from the south for this purpose.

Although the Angus shore of the Tay estuary provides ideal sites for shipbuilding yards, other factors have prevented Dundee from retaining the position it once held as a major centre of the industry. The Clyde is close to the steelworks which supplies its plates, while in the neighbourhood of the Tay the spontaneous growth of a steel industry is improbable owing to the distance from supplies of coking coal, the Fife coal being particularly poor for this purpose. Nevertheless, the Tay is still second only to the Clyde in Scotland.

In the nineteenth century the Tay had advantages in certain sections of the market for ships. A large fleet of fully-rigged ships was employed bringing jute from India, and many of these vessels were built in Dundee yards. Some of them are still afloat, and even now the Tay is well represented in the annual grain race from Australia. One of them, the Lawhill, retains her original name, though she no longer flies the Red Ensign. Further, until early this century Dundee was an important whaling and Arctic fishing port, and consequently a local demand existed for the specialised types of vessel needed for these purposes. Such was the reputation of Dundee yards for ships built to withstand ice that the first " Discovery " was built there. Jute is now carried by the passenger and cargo liners plying between India and the Thames ; the whaling industry has moved elsewhere, and fishing is quite unimportant. The local market for ships has therefore disappeared.

Nevertheless, the sole remaining yard has been relatively prosperous in recent years. Activity has followed the same general trend as elsewhere, but the slump came later and recovery began earlier than in many other centres. The year 1930 made a record with 41,000 gross tons launched, and although 1938 was a year of closely comparable activity, launches amounted to only 31,000 tons. The slump in output lasted from 1932 to 1935, when for four years launches never reached 5,000 tons a year, but since then launches have exceeded 20,000 tons annually. The present year may break all previous records, as there were more than 27,000 tons under construction at the beginning of the year and an order for three sister ships with a total tonnage of a similar amount has been secured.

The Caledon Yard enjoys a high reputation for passenger-cargo liners of about 9,000 gross tons, and many ships of this type have been built for the Blue Funnel Line of Liverpool, the Glen Line of London, and The Netherlands

Steamship Company of Amsterdam. They have also constructed many tankers for both British and foreign owners. Another speciality has been steamers and motor ships for coastal trade. In its list of launches the names of the same owners recur frequently, and repeat orders for sister ships are common, facts which speak for the quality of ships built on the Tay.

All branches of engineering are carried on in Dundee or its immediate neighbourhood, but with the exception of textile engineering, the scale of production is designed to cater primarily for local demand. The firms engaged include several well-known local firms and a branch of a combine operating in several textile centres. All types of machinery required for the flax, hemp, jute, and linoleum trades are constructed both for the Dundee industries and for Calcutta. The demand for such equipment suffers considerable fluctuations, and plant for a variety of processes is also made. There is also an interesting example of a small but prosperous firm making electrical equipment which was founded as a deliberate attempt to diversify Dundee industry.

The natural advantages of the Tay estuary as a harbour cannot, unfortunately, be fully exploited as there is no densely populated hinterland for the port to serve. The port is very largely dependent on the jute trade, and dues on raw jute alone provide about 40 per cent. of the revenues of the Harbour Trust. Hence the requirements of that industry have been the determining factor in the lay-out of the docks. The considerable length of the deep water wharves on the river front is to be explained by the fact that raw jute imports were formerly highly seasonal. In recent years supplies have been shipped as part-cargoes and arrivals have been spread over eight months of the year. The trade in raw jute amounts to a million bales a year, and some half-million tons of shipping brings it in. The trade of the port is dominantly inward, for in addition to raw jute there are imports of sacks and gunnies, timber amounting to some 60,000 loads a year, esparto grass for the local paper mills, raw sugar to occupy the Cupar refinery when the beet season is over, flour, and phosphates. Some hessian is exported from Dundee, but more is despatched from the Clyde or from English ports. The fact that the one important exporting industry of the town has its chief markets on the other side of the Atlantic makes it inevitable that goods will be despatched via the ports handling the Atlantic traffic. There is a direct service to the United States but sailings are not frequent. The liners which bring the raw jute pick up cargoes elsewhere for the outward passage to India. Much of the outgoing traffic is coastal trade, and potatoes for England are an important item.

The Jute Industry.

Jute is one of the cheapest textile raw materials, but it is, compared with cotton or flax, coarse, relatively brittle, of unattractive appearance, and difficult to dye in fast bright colours, so that the industry has tended to develop by substituting jute for other materials in uses where cheapness is the primary consideration. Some 70 per cent. of the world's output of jute cloth is used for packing purposes, either made up into sacks or as wrapping material. Next comes the use of the finest qualities of " hessian " as the base of linoleum and oilcloth, and the third major use is in jute carpets and matting. Apart from these there are less important uses too numerous to mention, but important in their aggregate consumption. The variety of

applications of jute can be seen from such examples as the use in brattice cloths for regulating mine ventilation, in upholstering furniture, in making the so-called buckram foundations of cheaper tailored garments, and as a wall covering. The yarn is used for purposes as diverse as the backing of carpets and rugs made of other materials, for making string, and as insulation in electric cables.

These are but a few of the many jute products made in Dundee, indeed there can be few which the city does not produce, but ever since the phase of rapid expansion in the local industry came to an end in the middle 1870's, the tendency has been for the cheaper fabrics and sacks to form a diminishing part of output, while more attention is paid to the production of the finer qualities of hessian and to certain specialised lines where the total demand is insufficient to attract the large-scale producers of Calcutta.

In 1914 the jute industry of Dundee had been nearly stationary for some forty years, while rival industries on the Continent, and above all in Calcutta, expanded. Since the war the output of the Dundee industry has declined slightly and that of its principal rivals has increased still further. The decline in output has not, however, even approached the dimensions of that suffered by the cotton industry. In pre-war days net imports of raw jute averaged 220,000 tons a year, compared with 197,000 tons in 1938, when consumption returned to approximately the pre-slump level. A similar decline in the production of yarn is shown by the census of production figures, which give an output of 116,500 tons for 1935, compared with 102,500 tons for 1930 and 132,000 for 1912. In the early months of this year output may have reached the pre-war level, but statistics are not available. The decline in the competitive position of Dundee is, however, greater than the figures show, for through Government intervention a certain amount of business comes to Dundee irrespective of price. Examples of this are orders for sandbags which could be placed more cheaply in India but are given to Dundee firms so far as local productive capacity permits ; Danish bacon must be imported in Dundee-made cloth, and subsidised British beet sugar must be packed in Dundee sacks. The effects of such arrangements can be seen from the fact that one standard grade of cloth can be delivered in Dundee from India at a price which covers only the spinning cost of a Dundee manufacturer. If it were competing in an entirely open market the rate of output at the present time would not compare so favourably with pre-war figures.

In pre-war days the industry exported about 40 per cent. of its output, and the proportion actually rose after the war to 52 per cent. in 1924, falling again to 45 per cent. in 1930. No inclusive figure can be given for a more recent year, but according to the 1935 Census of Production, exports of piece goods amounted to 31 per cent. and exports of carpets and rugs to 13 per cent. of respective outputs, and since piece goods are by far the more important, the average would be much nearer the former figure than the latter. In addition, some 5 per cent. of yarn is exported, and a small proportion of the piece goods output is exported as sacks. About 80 per cent. of the export trade is with foreign countries, half of it with the United States alone, so that the prosperity of Dundee is closely linked with that of America and also to changes in the height of barriers to international trade. As regards the home market, imports of yarn are negligible and those of carpets and rugs relatively unimportant. In the case of piece goods it is unfortunate that the trade

statistics do not distinguish between the different kinds so that the differences between the types of cloth imported and those which are exported do not appear. It is probably not far from the truth to say that the qualities exported are quite different from those imported. Until recent years retained imports of piece goods represented some 20 per cent. of home consumption, but since 1935 imports, which come mainly from British India, have increased each year, the figure for 1938 being nearly treble that of 1935. At the same time home production was greater in 1938 than in 1935 and exports were reduced by a third, so that Dundee's share of the home market was not reduced to the extent the import figures suggest. The increase in piece goods is due to circumstances in the Calcutta industry, of which some account may now be given.

Calcutta and Dundee may be regarded as sharing the world export market for jute goods between them, Calcutta being by far the bigger of the two. The members of the Indian Jute Mills Association, who represent 96 per cent. of productive capacity in India, consume five or six times as much jute as Dundee, but owing to restrictions on output in Calcutta, this comparison underestimates the relative size of the industry there. The general tendency is for Indian mills to cater for the bulk demands for the coarser types of fabric and to leave to Dundee the finer qualities and certain widths and weights of coarser cloths the demand for which is insufficient to make its production attractive to Calcutta. The Calcutta mills are highly integrated, spinning, weaving, and finishing being carried out in the same building; labour is cheap and transport costs are lower. Indian wage rates are much lower than those in Dundee, and even allowing for a lower efficiency of labour and the cost of white supervisory labour, which has no equivalent in Dundee, where "blackcoated" jobs are few, wage costs are lower in Calcutta. Dundee, on the other hand, has the advantage of a much more skilled and adaptable labour force, which has enabled it to dominate the market for better grades of hessian, particularly linoleum hessian. Cloth for backing linoleum must be particularly free from faults and free even from crinkles which might occur during packing or in transit. The production of perfect "pieces" six feet wide and 2,000 yards long requires skill and care of a higher order than will suffice for sacking. The lack of integration in Dundee, where spinning, weaving, and finishing are commonly carried out in separate establishments, even when these are under the same ownership, adds to the flexibility of the industry. Dundee factories are prepared to turn over labour from one cloth to another and are prepared to accept contracts on more elastic terms and for smaller quantities than those in Calcutta, whose system is most efficient when labour and machinery are engaged continuously on the production of the same cloth. Dundee business is thus being more and more confined to specialities which India could produce if necessary but which will probably be left to Dundee so long as a market can be found for the types of goods already produced. Any serious contraction of the market for Indian goods, however, would be likely to lead to an intensification of competition with Dundee.

A similar result might be brought about if the demand for jute goods remained stationary and productive capacity in India increased, and such a development has been threatened during the past three or four years. Since its foundation in 1884 the Indian Jute Mills Association has met temporary

declines in demand by restriction of output through reductions of working hours. In 1931 the members of the Association agreed to seal a certain proportion of their looms and to restrict the weekly number of hours the mills should work in order to maintain prices. The policy was changed in 1934 because mills outside the Association were extending production. In November 1934, under the agreement, the unsealing of looms began, and between April 1936 and March 1937 restrictions on working hours were removed. Instead of a complete return to the multi-shift system, most of the mills in the Association worked 54 hours a week instead of 40 as formerly. Some mills were working as many as 108 hours weekly. The policy was designed to coerce the mills outside the Association into joining a restriction agreement by forcing prices down to a level which was unprofitable to them. At the same time it inflicted considerable hardship on the higher cost producers of Dundee. The policy has succeeded in bringing about an agreement between all but a negligible proportion of producers in India and includes an arrangement for a boycott of firms which either sell to or buy from mills which are not parties to it. The threat to the Dundee industry from still further increased Indian output is thus temporarily removed, and at present the A.R.P. demand for sandbags is producing something approaching boom conditions, but in the long run its existence depends on how far it pays India to maintain an attitude of " live and let live " towards it. In certain ways it pays India that there should be an industry in Dundee. The same firms supply both with machinery ; new machines can be tried out in Dundee while Calcutta watches the results ; and Dundee also serves as a training ground for managerial personnel, but there are limits to the price India is willing to pay for these advantages.

During the present decade Dundee has thus been faced with first an unparalleled slump and then greatly intensified competition, while the trend of prices of jute goods has been downward for nearly 15 years. In the face of these adverse factors the industry has tried to reduce costs. Labour costs being a high proportion of total costs, these were the obvious point of attack. According to the Census of Production of 1935, the net output of the jute industry, i.e. the difference between the value of gross output and the cost of raw materials, fuel, and power, was £2,906,000, or £120 per person employed. The proportion of net output represented by wages was 69 per cent., compared with 85 per cent. in 1930. The average wage in 1935 was thus rather less than £83 a year. Wages are fixed by a Trade Board, and their level is influenced considerably by the level of Unemployment benefits and allowances. Wages being relatively rigid, the only available method to reduce wage costs has been through technical changes.* These have, however, been confined to the preparing and spinning section, where a movement to adopt new methods began in 1927 but was greatly accelerated after 1932. Labour has been displaced directly by the introduction of automatic can trampers and sliver roll formers to pack the sliver as it leaves the carding machines and drawing frames. The practice of giving each spinner two frames to mind instead of one, which although dating from pre-war days became almost universal during the slump years, reduced the number of spinners, who are relatively

*I am indebted to an unpublished paper by Mr Dennis Chapman for data concerning recent technical changes.

highly paid. The demand for juvenile female labour has been reduced by the elimination of the squads of girls who used to replace full bobbins by empty ones. Labour has been indirectly eliminated by the speeding up of all machinery and increasing the capacity of cans and bobbins.

These technical changes involved heavy expenditure on new machinery, and in order to cut capital costs a shift system was introduced. The availability of cheap electricity during the night was also a factor in favour of night shifts. Some indication of the amount of technical change can be obtained from the fact that the industry consumed twice as much electricity in 1935 as in 1930, although the total yarn output was barely 10 per cent. greater. Several modifications of the shift system are in operation. Where men are working alternately on day and night shifts, a few boys are employed during the daytime and women on the day shift do the winding for both shifts. In one case men over the age of 21 form 65 per cent. of the labour force, and only 15 per cent. of female labour is used ; a complete contrast to the old system where few adult men were employed. Another modification is to run the day shift on traditional lines with boys under 18 and women and to use young men 18-21 on the night shift. The shift system is still in the experimental stage, and the night shift is unpopular with young workers ; housing conditions in Dundee make adequate daytime sleep very difficult to obtain. In some cases the rate of labour turnover is believed to be very high. Some degree of compulsion is exercised through the loss of six weeks' employment benefit which follows from leaving a job without reasonable excuse.

The effect of these changes has been to increase the proportion of males to females *actually employed* from 1 : 2·1 in 1924 and 1 : 2·5 in 1930, to 1 : 1·7 in 1935. The proportion of juvenile labour has likewise fallen, for males from 1 in 4 in 1924 to 1 in 5 in 1935, and for females from 1 in 6 to 1 in 7. Until the early 1930's Dundee had a serious problem of unemployment among young men who had been dismissed at the age of 18 when they became eligible for the next grade in the Trade Board wage scale. They had little chance of ever being employed in the jute industry again. Under the new system fewer boys are taken on at school-leaving age and at 18 they are offered jobs on the night shift. There is a likelihood under the new arrangement that in future men will be thrown out of employment at 21 if the supply of men between 18 and 21 suffices for the night shift, but although the problem exists it is not important as yet.

These technical changes have been accompanied both by a reduction in the numbers of workers nominally attached to the industry and by heavy unemployment. In 1930 some 41,000 persons aged 16-64 were registered as jute workers under the Unemployment Acts, and of these approximately 35,000 were in Dundee. Corresponding figures for 1938 were 28,000 for the industry and rather more than 24,000 in Dundee. Most of the reduction in the numbers of insured persons is accounted for by a fall in the number of insured females, which may be partly attributed to the operation of the Unemployment Insurance Anomalies Act, which caused many married women to drop out of the unemployment statistics. In 1931 there were 12,380 insured males and 27,770 insured females, while in 1938, excluding juveniles, there were 10,760 males and 17,220 females, so that the number of males has fallen only 13 per cent. compared with a fall of 38 per cent. in the number of females. This decline in numbers has been accompanied by heavy unemploy-

ment. From February 1930 until June 1933 the percentage unemployed was never less than 30 ; the average for 1931 was nearly 50 per cent., and in that year and again in 1932 extended holiday periods raised the percentage to over 70. At the time of writing (March 1939) some 20 per cent. are unemployed despite the high level of activity in the industry, and this figure may be taken to represent the surplus of labour which still exists.

The industry has thus made considerable efforts and labour has suffered severely in the process of adaptation to changed conditions, but events have moved still more rapidly. Still more contraction is probably necessary before an uneasy equilibrium is reached at that level of output which Calcutta is at present willing to leave to Dundee. Both a tariff and a quota system have been advocated as a means of maintaining the present level of output, but both now appear to be ruled out for the next five years by the Anglo-Indian Trade Agreement. In any case, a quota would probably be unacceptable to the Government, which has been unable to place all the sandbag orders it was willing to give to Dundee. It would deprive home consumers of supplies which at present Dundee could not produce, and further, it would certainly invoke coercive competition from Calcutta in the export market in those lines where Dundee now encounters little rivalry. Potential losses of trade in the export market are at least as great as any probable gains in the home market. The same argument applies, but to a lesser extent, to the use of a tariff. It would be necessary to find a level of tariff which would give a profit margin sufficient to prevent further contraction of the industry and yet which would not reduce the trade of the Indian mills sufficiently to cause them to take retaliatory action. At present the industry feels itself precariously balanced on the edge of a precipice and, if it falls over, the city of Dundee will be largely dependent on Unemployment relief.

XI.

GOVERNMENT AND PEOPLE—SOCIAL SERVICES

BY

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THE development of the social services in this country has been probably the greatest feature of national life since the beginning of the present century. To define exactly what is meant by the term "social services" would be rather difficult, and in the Report of the Committee on National Expenditure published in 1931 (the May Report) it is stated that "no clear definition of the category of social services has ever been laid down." The services covered by the term, however, are sufficiently well known to render any attempt at an exhaustive definition unnecessary, and they may be grouped roughly under three heads :—

(a) Relief of destitution ;
(b) Provision of health services (including housing) ; and
(c) Provision of education and educational facilities.

The first is clearly a social service, and the other services may be described as social in that they are provided for the recipients irrespective of ability to pay for them, the only qualification being need.

The social services are provided by the central government, or by the local government, either with or without State aid. The services provided by the central government are, with two exceptions, based on a scheme of insurance, or quasi-insurance, the benefits being granted primarily not by reference to the needs of the recipient, but in return for contributions paid and, in certain cases, varying in amount according to the contributions paid. The principal schemes of this class are unemployment insurance, national health insurance, and contributory widows' and orphans' and old age pensions schemes. These schemes, however, though based on the principle of insurance, confer benefits on the recipients on a scale far in excess of what would be covered by an ordinary insurance, on an economic basis, of the risk involved. The major schemes of unemployment insurance and national health insurance are confined to the wage or low salary earning classes, and while it is only the employee who receives the benefits, the schemes are maintained by contributions, not only from the employee, but from the State and the employer, so that these schemes are also social services in substance if not in form.

The two exceptions of the government schemes which are not based on insurance are (a) Old Age Pensions under the original Act of 1908, and the extension of that Act to Blind Persons of 50 years of age by the Blind Persons Act of 1920 (the age being reduced to 40 by the 1938 Act), and (b) Unemployment Assistance under the Unemployment Assistance Act, 1934.

It is principally with the social services provided by the local government authorities that I propose to deal. It would be impossible for me to deal with all the aspects of the question or to go into major questions of policy, and I propose merely to discuss the administration of the various services.

(a) Relief of Destitution.

The relief of destitution is the principal social service, and the other services are, to a considerable extent, branches of it, but all the services have developed to such an extent that each must now be regarded as a separate entity.

The relief of destitution is a service which had its beginning long before the twentieth century. In Scotland the maintenance of the poor from local rates was instituted by the Act of the Scots Parliament, 1579, c. 74, which authorised the levying of a tax in every parish for the support of the aged and impotent poor. The granting of relief to able-bodied poor was not authorised under the earlier Poor Law Acts. This system continued as the basis of Scottish Poor Law down to 1921, when the tremendous increase in unemployment consequent on the post-war depression led to the passing of the Poor Law (Emergency Provisions) (Scotland) Act, 1921, which extended the granting of relief to able-bodied persons provided they were destitute and unable to obtain employment. In 1930 the Local Government Act of the previous year abolished the parish as the unit of administration and substituted the city, county, and large burgh, thereby equalising the burden. The Poor Law (Emergency Provisions) (Scotland) Act, 1921, was passed as a temporary measure, and was renewed from year to year down to 1934, when its provisions became permanent under the Poor Law (Scotland) Act, 1934.

The relief of the poor by local authorities under the Poor Law Acts is not assisted by the State, and is the only major social service administered by the local authorities which is not so assisted, but the burden of this expenditure on local rates was lightened considerably by the Government in 1936 when the Unemployment Assistance Board, established in 1934, took over the relief of the able-bodied poor who were still normally in employment covered by the Health Insurance Acts.

Relief by the public assistance authority is granted either by way of outdoor relief—a weekly cash payment to the recipient (supplemented by grants of clothing and, where necessary, medical benefits) or indoor relief—maintenance in an institution. Outdoor relief is the more usual form of assistance, and indoor relief is generally only provided where the applicant requires care and attention which can only be provided in an institution or where the habits of the applicant are such that the grant of outdoor relief is undesirable, as, for example, the case of the habitual drunkard.

The institutions provided by the public assistance authorities consist of the poorhouse and the poor law hospital. In the case of the larger authorities these are separate institutions, but in the smaller areas there is usually only one building, with separate blocks or wards. The larger authorities also provide separate institutions for children to ensure their being kept apart from the environment of the poorhouse. The poor law hospitals were originally provided solely for the treatment of poor persons requiring medical care and treatment. Section 27 of the Local Government (Scotland) Act, 1929,

however, empowered local authorities to make available general hospital treatment apart from the poor law and enabled them to provide, in their poor law hospitals, for persons not in receipt of public assistance, or to build additional hospital accommodation. Prior to the Act local authorities had only power, apart from the Poor Law, to provide accommodation for specific infectious diseases (mental hospitals prior to the Act were provided by District Boards of Control which were superseded by the local authorities in the cities and counties). Where the local authorities have made their poor law hospitals available as general hospitals, however, they must make a charge for treatment in the case of patients other than persons receiving poor relief, whereas in the infectious diseases hospitals treatment is provided free. The intention of Section 27, in empowering local authorities to provide general hospital facilities, was principally to relieve the pressure on the voluntary hospitals, but, apart from the four cities and one county, no provision for this public health service has yet been made. The place which these hospitals will take in the general scheme of hospital services has not yet been clearly defined, but it is probable that in the future local authorities, at least in the cities, will be required to provide general hospitals for the treatment of sub-acute and chronic cases requiring routine medical and nursing attention and leave the voluntary hospitals to deal with cases involving specialised medical or surgical treatment.

This part possibly relates more to public health than public assistance, but I have dealt with it in this section because of the fact that it has developed from the poor law services.

(b) Provision of Health Services.

The origin of the public health services in this country probably dates from about the middle of last century, but it was not until the beginning of the present century that they developed as social services. The original public health services were directed principally towards the provision of sanitation, the removal of nuisances, and the control and treatment of infectious diseases, not from the point of view of the health of the sick, but for the protection of the community at large.

The safeguarding of the health of the community at large still forms the basis of the health services, but along with this there has developed the idea of public health as a social service, and most of the public health services provide an intermingling of both principles. An example of this will be found in the development and extension of the treatment of tuberculosis. The general provision of sanatoria by local authorities dates from about 1906, but these institutions at the beginning could do little more than prevent the spread of infection by the segregation of sufferers from the disease. Since that date these institutions, with the advance of medical science, have been increasingly successful in effecting cures, and within recent years many of the sanatoria have gone even further by training patients in some new occupation of a congenial type in which they may engage on leaving the institution without detriment to their condition and in which they will be able to earn a livelihood.

The power of local authorities to provide for the prevention and treatment of infectious diseases was conferred by the Public Health (Scotland) Act, 1897. The school health services were originally provided for under the

Education (Scotland) Act, 1908, but these services did not come under the control of the local public health authorities until 1930, so that, so far as the local authorities' health services are concerned, the next statutory developments may be taken as the Notification of Births (Extension) Act, 1915, which authorised the local authorities to make arrangements for attending to the health of expectant and nursing mothers and of children under five years of age, and the Maternity and Child Welfare Act, 1918, which authorised the erection of maternity hospitals. In addition, the Midwives Act of 1915 conferred powers on local authorities with regard to the provision of medical assistance in case of emergencies arising at confinements, and the Maternity Services (Scotland) Act, 1937, provided for the establishment of a complete domiciliary service, including a medical practitioner and a midwife, with the assistance of an expert obstetrician, if necessary.

In connection with the administration of maternity and child welfare schemes, there are provided clinics where advice is given by medical officers of the local authorities to expectant and nursing mothers, and home visitations are made by health visitors employed by the local authorities.

In addition to the provision of medical and nursing facilities, the local authorities also provide food and milk under the Maternity and Child Welfare Schemes to mothers and children who are found to require additional nourishment for the maintenance of their health.

The school medical services now form a very important part of the health services of the local authority. As already stated, provision for these services was made by the Education (Scotland) Act, 1908. The 1908 Act authorised School Boards to conduct the medical inspection and supervision of school children, and the Education (Scotland) Act, 1913, authorised them to provide treatment. The powers of the School Boards were transferred to Education Authorities in 1919, and in 1930 *ad hoc* Education Authorities were superseded by the County Councils, and the Town Councils of the four cities (Edinburgh, Glasgow, Aberdeen, and Dundee).

The following quotation from the Report of the Departmental Committee on Scottish Health Services (1936—Cmd. 5204) describes fully the present scope and extent of the school medical services :—

" The scope and aims of this service were defined in a joint memorandum issued by the Department of Health for Scotland and the Scottish Education Department in 1929 as follows :—

> " (a) To provide such conditions of school life as will, as far as possible, secure healthy growth and development and prevent sickness and incapacity among school children.
>
> " (b) To provide for the systematic medical examination of school children and their supervision throughout school life.
>
> " (c) To follow up and keep under supervision all children found to be suffering from physical or mental defect.
>
> " (d) To provide appropriate treatment for the children of necessitous parents, and to secure that all parents shall have their children treated when necessary, whether privately or at the public expense."

" The following is a summary note of the arrangements made under school health schemes :—

" In the course of a child's attendance at school three routine medical examinations are carried out, generally at ages 5 to 6, 9 to 10, and 13 ; a test

of vision is usually made at age 7. An additional examination is made of children continuing at secondary schools. Re-examinations are made of children found with defects, and special examinations of children put forward by parents, teachers, or school nurses. In one area, the examination of the age group 9-10 is omitted and an annual classroom survey of all children is made by the medical officers with the co-operation of the teachers ; children who then appear to require a fuller examination are referred for medical examination.

" Parents are notified of conditions that require treatment and are recommended to seek the advice of the family doctor. For children of necessitous parents treatment is provided by the local authority either at a centre or by other arrangement. A system of ' following-up ' by school nurses is in operation. These nurses visit the houses and urge the parents to obtain the necessary treatment for their children, explaining the facilities available.

" Provision varying in kind and in adequacy is made by local authorities for the suitable education of exceptional children (physically or mentally defective, blind, partly blind, deaf and dumb, epileptics, etc.) in ordinary schools or special schools and by arrangement with voluntary organisations.

" Other activities under the school health service include the following :— Assistance with arrangements for feeding school children and securing that such arrangements are made where necessary ; the supervision and control of the hygiene of the schools ; advising on the structure or internal arrangements of schools which affect the health of the pupils and, where consulted, on school sites and playgrounds ; the supervision of physical education, instruction in personal hygiene, co-operation with the other public health services."

Provision is now also made for the examination of the child before leaving school to determine his suitability or otherwise for certain classes of employment, and a copy of the report of this examination is sent to the Local Committee for Juvenile Employment. In addition, the school health records of pupils are transmitted to the Health Insurance Committee so that the medical history of the pupil is available for the use of his panel doctor when he enters insurable employment.

The public health services have grown considerably during the last twenty years, and all tendencies at present point to a still further development in the future both by extension of the existing services and provision of new services, such as that introduced by the Cancer Act, 1939, under which local authorities are bound to make arrangements for securing that facilities for the treatment of persons suffering from cancer are adequate for the needs of their areas.

It would be very difficult to forecast on what lines development and expansion will take place, but co-ordination of the work of local authorities' hospitals and the voluntary hospitals will probably be dealt with in the near future and provision made for filling in the gaps which at present exist between the child welfare schemes and the school medical services. There are at present in Dundee two nursery schools for children between the ages of two and five, and it is probable that in the future nursery schools will provide for children between two and seven years of age, and thus cover the period included at present in the infant department of the primary schools.

Schemes for the welfare of the blind under the Blind Persons Acts of 1920 and 1938 are also administered by the local authorities as part of the public health services, provision being made for the training of blind persons and for the maintenance of the necessitous blind. In addition, under the latter Act necessitous blind persons are also granted an allowance for their dependents, so obviating the necessity of such dependents having to resort to public assistance.

In dealing with the social services of the local authorities I have not so far dealt with the housing question. Housing and environment play an important part in the social services, and the fact that I do not discuss the housing question at length is not because I minimise its importance, but because the question is so large that it would be quite impossible to deal with it adequately within the limits of this article. However, I should perhaps relate briefly the development of post-war housing.

The complete cessation of house-building during the war led to a very acute housing shortage in the immediate post-war period, and in 1919 the Government passed an Act enabling local authorities to proceed with the erection of houses with the assistance of a government grant. The high cost of building at that time would have made the rents of the houses prohibitive had they been fixed on an economic basis, and it was accordingly necessary to provide a subsidy. Towards this subsidy the local authority provided a sum equal to the produce of a rate of four-fifths of a penny per pound, and the Government provided the balance, the Government contribution being by far the greater share of the deficit.

Subsequent housing legislation was directed mainly towards the clearing out of slum areas, the Acts of 1923, 1925, and 1930 making provision for the erection by the local authority of houses for persons living in properties unfit for human habitation. The Housing Act of 1935 went further by providing for the rehousing of persons living in overcrowded conditions, so that in the eradication of the slums and the relief of overcrowding the provision of housing accommodation has now become one of the principal health services of the local authorities. Towards the cost of the erection of houses for persons living in slums or in overcrowded conditions the local authorities receive subsidies from the Government and they themselves also contribute towards the cost.

(c) Provision of Education and Educational Facilities.

The provision of education by the local authorities may probably be regarded as one of the social services, but I do not intend to deal with the provision of education itself, but with the provision of educational facilities, i.e. the facilities provided by the local authority to enable the child to take full advantage of education provided.

By the Education (Scotland) Act, 1908, where parents are unable by reason of poverty or ill-health to supply sufficient and proper food or clothing for their child, the school boards were authorised to make such provision for the child as they might deem necessary during the period the child was under obligation to attend school.

The Act also authorised the payment from the education fund of expenses incurred in bringing opportunities for education within easier reach of children in outlying parts of their district, either by providing means of conveyance,

or paying travelling expenses for teachers or pupils to and from their homes, or defraying the cost of lodging pupils in convenient proximity to a school.

Special provision was also made in this and other Acts for the education in special schools, homes, or other institutions of blind, deaf-mute, epileptic, crippled, or defective children.

The Education (Scotland) Act, 1918, empowered education authorities, with a view to securing that no child who is qualified for attendance at a secondary school and who, from the reports of the teachers, is likely to profit thereby, shall be debarred by reason of expense, to grant assistance to such child by payment of travelling expenses or fees, or cost of residence in a hostel, or of a bursary or maintenance allowance, and the authorities were also authorised to assist any adult qualified person in their area to attend a university or other central institution for higher education.

Under the Milk in Schools Scheme of the Milk Marketing Board, as approved by the Scottish Education Department, milk is supplied by the Milk Marketing Board to children in schools at one half of the ordinary rate, and in many cases the Education Authorities arrange for the provision of milk in necessitous cases entirely free under the general authority of the 1908 Act.

This paper is intended to be informative only, but on the assumption that every child coming into this world is entitled to find reasonable opportunity to live a healthy and happy life, the natural extension of the social services will suggest itself to every member of the British Association and, in particular, to those of them who are members of local authorities.

XII.

EDUCATION IN DUNDEE

BY

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DUNDEE can scarcely be ranked as one of the distinctive cultural centres of Scotland. For such a distinction Edinburgh and Aberdeen have stronger claims. Yet it would be a mistake to undervalue Dundee in this connexion. It has to be remembered that the city stands somewhat apart from the main centres of population. If its institutions of higher learning were late in development, that is due in part to the isolated position of the city, in part also to the fact that in the near neighbourhood the ancient University of St. Andrews provided adequately enough for the cultural needs of the district.

THE HIGH SCHOOL.

The early history of education in Dundee centres round the story of the old Burgh or Grammar School, now represented by its direct successor, the present High School of Dundee. Dundee has always been amongst the most important of Scottish towns. It was one of the first towns to develop a continental trade, its favourable situation on the edge of the fertile Carse of Gowrie giving it a certain advantage which its merchants knew how to exploit. Historical records make it clear that the Scottish burghs early showed an interest in education. Most of them seem to have been provided with grammar schools before the end of the thirteenth century.

The Dundee Burgh School dates from the reign of Alexander II. The precise year of opening is a matter of conjecture, but it is at least 700 years old. A document exists (*circa* 1220 A.D.) in which the Bishop of Brechin grants to the Abbot of Lindores permission to open a school, and we know from later references that the permission was acted upon. If Blind Harry is to be relied upon, Sir William Wallace was a pupil of the school. In 1434 we read of a certain schoolmaster of Dundee who was dismissed at the instance of the Bishop of Brechin because he had ignored the Bishop's orders. At a later date the burgh schoolmaster got into trouble with the Church authorities for spreading the Lutheran heresy among his pupils. In this he seems to have had the backing of the magistrates, well known for their sympathetic attitude to the reformed doctrines.

The school had a considerable reputation for the teaching of Latin. The usual course in the grammar schools in Scotland extended over five years, but for a considerable time Dundee undertook an ambitious seven years' course. The method in use was the direct method, Latin being still regarded as a living speech, and the writings of scholars like Erasmus and George Buchanan being placed on an equal footing with the works of Cicero and Virgil. Among distinguished pupils of these early days were Hector Boece, historian, and first Principal of Aberdeen University, and Sir George Mackenzie, founder of the Advocates' Library in Edinburgh. The classical tradition established in early times has been worthily maintained by the school up to the present day, as the records of Edinburgh and St. Andrews Universities clearly show.

The Sang Schule.

Burghs in Scotland acknowledged the obligation of supporting only two schools—the Grammar School and the Sang Schule. Before the Reformation the Dundee Sang Schule stood near the Parish Church at the south-west corner of what was then known as School Wynd, now South Lindsay Street. We know little about it, but the reference to Sir John Fethy, a master of the Sang Schule in 1531, is important, since that musician is recorded by Wood in his Psalter of 1566 as being " the first organeist that ever brought into Scotland the curius new fingering and playing on organs." Fethy must have been a first-rate musician, for he received similar appointments later in Aberdeen and Edinburgh. At the time of the Reformation the Sang Schule was " roupit " by order of the Council, but we find in 1584 that it had been restored with John Williamson as its master as an elementary school, in which reading and writing with both vocal and instrumental (the virginalls) music was taught. The sack of the city by Monk in 1651 led to the closing of the school for a time, but it appears again in 1652, when George Runsiman was appointed its master. During the eighteenth century the prosperity of the school varied with the capability of its masters, who, in some cases, let the standard of music teaching fall or were unpopular owing to their political opinions. Until the early years of the eighteenth century the Mastership of the Sang Schule carried with it the precentorship in the Parish Church, but, by the third decade, we find masters in other schools obtaining the precentorship. The Council gradually gave up its insistence on the monopoly of the music school in the teaching of the art, especially when professional musicians became more numerous, and the Sang Schule merged into one or other of the schools of the burgh.

The English School and the Dundee Academy.

The magistrates of Dundee, while they maintained the old grammar school, were not insensitive to the demand that characterised the middle and latter half of the eighteenth century for a less narrow type of education. To meet the demand for something more than the standard curriculum of Latin, Greek, and Mathematics offered by the grammar school, the Town Council, in the year 1702, founded the English School for the study of English, reading, writing, and book-keeping. In the latter half of the century they opened, in 1786, a third school, the Dundee Academy. Classics was excluded from the curriculum, but French provided a reasonable substitute, and Italian, drawing, and applied mathematics were included. One of the teachers was James, afterwards Sir James, Ivory, the distinguished mathematician. It is on record that one of the magistrates, when he learned that a new and mysterious subject called Algebra was being taught, proposed " to put Jamie Ivory awa', as they had already a guid enough teacher of the alphabet."

At the end of the eighteenth century, therefore, Dundee had three schools for secondary education, and it soon became apparent that it was unnecessary to maintain all three. They were ultimately combined and housed in the present handsome building at the top of Reform Street. The joint school was known as the Public Seminaries, but this somewhat unsuitable name was abandoned later and the present name, the High School of Dundee, was substituted.

In normal circumstances the High School would have passed into the charge of the School Board after the passing of the Education Act of 1872. As a matter of fact, the School Board actually did lay claim to the school, but one of the magistrates, Bailie William Harris, offered the School Board the sum of £10,000 if they would forego their claim. With this money the School Board built a secondary school, the Harris Academy, and Bailie Harris then gave a further sum of £20,000 to the High School. The arrangement was embodied in an Act of Parliament under which a directorate was appointed for the High School. Under Bailie Harris' will an additional sum of £25,000 became available, and with this sum the Girls' High School was built.

Secondary Schools.

Besides the High School, Dundee possesses two other large secondary schools, Morgan Academy and Harris Academy, and two smaller ones, Grove Academy and Lawside Secondary School, the latter a Roman Catholic school. Morgan Academy, originally Morgan Hospital, was erected in 1868 for the accommodation of 100 boys, in accordance with the will of Mr John Morgan, a native of the city. At a later date the Educational Endowments Commissioners recommended that the terms of the Morgan Trust be departed from, and the buildings were acquired by the Dundee School Board and opened as a secondary school, now known as Morgan Academy. Harris Academy and Morgan Academy are amongst the largest of Scottish secondary schools, and although their history goes back for little more than fifty years, as against the seven centuries of the High School, they have already built up a splendid reputation and produced an impressive list of old pupils distinguished in the various walks of life.

Central and Other Schools.

In addition to its five secondary schools, Dundee possesses four large central schools, Stobswell, Logie, Rockwell, and St. John's. With the raising of the age some further addition may be necessary. Already a fifth is nearing completion, together with an extensive annexe to Stobswell, the first of the central schools and one of the first of its kind in Scotland.

In addition to the secondary and central schools, Dundee has 30 primary schools, three special schools, and a nursery school. The school population approaches 27,000, and more than 900 teachers are required to run the schools. At one time there were several good private schools in Dundee. To-day there is only one of standing, Seymour Lodge School for Girls, founded nearly 100 years ago, and still filling a useful place in the educational life of the city.

The provision for the education of the young people of Dundee is thus adequate. For a while Secondary education was hampered by the imposition of fees in all the secondary schools. Fortunately this handicap has now been removed in all schools under the Education Committee, although there is still a good deal of dubiety as to the best method of determining which pupils are best suited for the full Leaving Certificate course and which for the less strenuous standard of the Central Schools. Some of the school buildings are amongst the finest and best equipped in the country. Unfortunately there still remain in use several very unsuitable buildings, the evil heritage of a

parsimonious past, when economy was deemed more important than education. Commercial education, now that a series of National Certificates has been established, is satisfactory, but technical education for young people leaves something to be desired.

Technical Education.

The provision of technical education for young people who have left school is one of the weak points in the educational arrangements of the city. There is only one day continuation class. This is organised by the painting trade in the winter months for its young apprentices. As regards evening continuation classes, boys and girls on leaving day school show a distinct disinclination to join them. A pupil who takes a Day School Higher Certificate, testifying to three years of successful post-qualifying work, may enter the Technical College direct. Those who have not reached this standard must qualify for admission by attending evening continuation classes for two years. The result is that the number of students entering the Technical College is smaller than it might be. A very large proportion of those who enter on a five years' course leading to a National Certificate fail to complete the course. In the opinion of some the standard is too advanced for many of those who enter, and the Education Committee of the city is now organising a Trades School for the purpose of meeting this difficulty. Consultations with representatives of the various trades have been held, and temporary premises have been reserved and adapted for the purpose. This represents the first steps in a movement that is bound to grow if the needs of the city as regards technical education are to be adequately met.

Higher Education.

The institutions for higher education in Dundee are all of recent growth, having been developed within the last 50 years. The city now possesses a University College, a Technical College, a Training College, a School of Art, and a School of Economics. Of these the oldest is the University College, dating from 1883. The relations between the University College and the University of St. Andrews are somewhat complicated. They gave rise to a certain bitter feeling in the early days of the history of the College, and even yet an occasional article or letter in the local press, not always judicious or well-informed, recalls unhappy memories of the friction that characterised the earlier association of University and College.

University College.

The establishment of a University College in Dundee was first suggested by Dr. Boyd Baxter, and at a public meeting in 1874 it was resolved to establish a College to be affiliated to the University of St. Andrews. Some years elapsed before a sufficient endowment was obtained. The sum of £120,000 was subscribed by Miss Baxter of Balgavies, to which Dr. Baxter added a further £10,000, and in all a capital sum of £350,000 was forthcoming. This enabled a start to be made. The College was founded in 1880, and three years later teaching began.

To begin with the College had no University connexion, but in 1886 Edinburgh University agreed that science students from Dundee would be allowed to count two years spent in the University College as part of the three years' attendance required for the Edinburgh degree. St. Andrews followed the example of Edinburgh, accepting the whole curriculum in science, and soon afterwards a special clause in the Universities Act of 1889 provided that the University College should be affiliated to St. Andrews University. All along there had been a certain amount of opposition on the part of various persons interested in the prosperity of St. Andrews, a fear lest the success of the new College might imperil the prospects of the old University. This led to a regrettable occurrence. In 1895, as the result of a legal action initiated by certain supporters of St. Andrews, the union was dissolved, a serious blow for Dundee, whose students began to desert it. Fortunately this unhappy state of affairs lasted for two years only. In 1897 new terms of union were accepted, and the University College became once more an integral part of St. Andrews University, the College retaining its own Council for the control of its finances, but subject to the control of the University in all its academic work.

The College began in 1883 with five professors, but there has been marked development since then. Full degree courses are now provided in Arts, Science, Medicine, Dentistry, and Engineering, and there are in addition classes in Scots Law and Conveyancing. The teaching of law is to be extended this year with a view to the institution of a faculty of law and a law degree.

Technical College.

The Technical College and School of Art was opened in 1911. For many years instruction in Science and Art had been carried on by various interested bodies. The directors of the High School were the pioneers as far as art instruction was concerned. Classes in art were run by them even before the 1867 meeting of the British Association in Dundee, but instruction in science was not available till 1871, when the directors of the Y.M.C.A. formed a Science and Art Committee, and with the help of grants from South Kensington instituted large classes for the instruction of artisans and skilled mechanics.

Sir David Baxter, Bart., of Kilmaron, at his death in 1872 left the sum of £10,000 for erecting a Mechanics' Institute, and a further sum of £10,000 for its endowment. His trustees, deeming the money insufficient, delayed action till 1887, when they made an arrangement with the University College to co-operate in carrying out the scheme. A site in the College grounds was obtained and a Technical Institute erected in 1888. In 1902 the Y.M.C.A. classes and those run by the directors of the High School were stopped, and all technical classes in the city were taken over by the Technical Institute, which was then recognised by the Education Department as a Central Institution. In addition to the new Technical Institute various other buildings had to be used in order to cover the work, and as this led to some inconvenience, steps were taken to provide an adequate institution. Sir William Henderson, the Chairman of the Governors, took the lead in raising the necessary money, and in 1911 the present Technical College and School of Art was erected at a cost of £80,000. Of this sum £10,000 was subscribed by Sir William Ogilvy Dalgleish, and a further £24,000 by various subscribers, the Scottish Education Department providing a grant of £35,000.

School of Art and Duncan Bequest.

Independently of the Technical College and School of Art a very valuable bequest, the Duncan of Jordanstone Bequest, has made it possible to provide and equip a College of Industrial Art. A variety of difficulties has prevented the scheme being put into operation. Mr Duncan died about 40 years ago, and left a sum of money, at present worth £170,000, half of it to provide for the erection of the College and half for its equipment. Under the Educational Endowments Acts of 1928 and 1931, the terms of the bequest have been modified, and plans for the erection of the College have been approved and the work commenced. Under the new arrangement, which has been approved by the Education Department, the present Technical College and the new School of Industrial Art will be controlled by the one body of governors, each College having its own Principal. Provision is made under the Duncan Bequest for the inclusion of a department of domestic art.

Training of Teachers.

Dundee Training College, opened in 1920, is one of the four Scottish centres for the training of teachers. A local training committee had been established in 1899 and had been training teachers for six years when a Minute of Council in 1906 established four Provincial Committees, one for each university centre. The new committee at once took over the responsibilities of the local body as well as those of a St. Andrews committee which had been operating since 1895. The Provincial Committee is representative of the various educational bodies throughout the province, county councils, university, teaching profession, church, and central institutions. The foundation stone of the Training College, a handsome building in Park Place, was laid in 1912, the year of the previous visit of the British Association to Dundee. Owing to interruptions caused by the war, eight years elapsed before teaching began. The College provides training for teachers of every kind, graduate and non-graduate teachers, teachers of Art, Music, Handwork, etc. A special feature of the work is the emphasis laid on the training of teachers for rural schools. There are many small country schools within easy reach of the city, and these are freely and regularly used for the practical training of the students.

A Demonstration School attached to the College provides the students with opportunities for practical and experimental work. There is also a Child Guidance Clinic where difficult children from the city schools are taken in hand. These, with an attractive hostel and a large playing field, complete an equipment suitable in every way for the work the Committee is called upon to undertake.

School of Economics.

The School of Economics was gifted to Dundee by the late George Bonar, Esq., one of the leading jute manufacturers. Mr Bonar, anxious to encourage commercial education, offered the necessary funds to St. Andrews University for the establishment of a Commercial College to be an integral part of the University. He hoped to provide in this way for the higher training of those young men and women who propose to embark on a commercial career. Certain technical difficulties prevented the University accepting the gift in

the form in which it was offered, and when the College was built it was ultimately put under the control of the Dundee Education Committee. It provides for two main classes of students—graduates of the University who seek to enter the higher ranks of commerce, and students in possession of a Leaving Certificate aiming at a commercial diploma. Both types are thus of university standing, and it may yet be possible to affiliate the School to the University. Under its able Principal, it has quickly built up a sound reputation and obtained an established position as a centre for advanced commercial training.

Adult Education.

While there is adequate provision for the higher cultural and professional education of those who seek to specialise, the provision of general adult education is less satisfactory. The city has a deservedly high reputation in music, and the number of dramatic and literary societies bespeaks a definite interest in mental culture generally. The English Association, which now numbers its members all over the Empire, originated in Dundee, and there is still in existence a Greek Club, whose members read through Homer once a year. The Workers Educational Association has a vigorous branch in the city, but it receives less support than might be expected. At one time the subjects most in demand were technical or industrial in their appeal, but there is now a more marked interest in subjects of a cultural type. These, it is interesting to note, seem to appeal to a neglected but very important class of worker, the busy housewife, immersed in domestic duties during the day, but eager for self-improvement when the opportunity offers.

XIII.

SCIENTISTS OF THE DUNDEE AREA

BY

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INTRODUCTION.

IN presenting these biographical notes on scientists of the Dundee area, it is interesting to compare the numbers which fall into the different branches of science.

It will be seen that the general naturalists and botanists predominate. This is perhaps natural when one considers the relatively late development of Dundee as an industrial centre and the wealth and beauty of the countryside surrounding it. It was also probably inevitable that some of the most distinguished of Dundonian scientists should have been drawn south to the great centres of learning there, where their native talents could find greater scope than in their native town. Nevertheless, in Patrick Matthew, George Don, William Gardiner, Charles Lyell, and James Bowman Lindsay, the Dundee area can claim inhabitants who have made their mark in the history of science.

PATRICK BLAIR, M.D., F.R.S., 1666(?)-1728.

Born about 1660 of an old Dundee family, Patrick Blair was a " surgeon-apothecary " and also a keen naturalist. References in his works lead one to suppose that as a young man (1695-97) he was with the army in Flanders. Settled again in Dundee, his position and friendship with the town's Provost lead to his being entrusted with the dissection of the carcase of an elephant which died on the road between Broughty Ferry and Dundee (through no fault of its custodians, as a certificate from the Provost attested). Blair's account of his work—the first dissection of an elephant in Great Britain—was published in the " Philosophical Transactions of the Royal Society of London," Vol. XXVI., for 1710-12, under the title, " Osteographica Elephantina." Over 100 pages of letterpress were accompanied by four copper-plate engravings executed in Dundee under Blair's own eyes. The interest and value of the paper lies not only in its priority, but in the accuracy of the observations.

The acquisition of this elephant inspired Blair to " engage several honourable and learned gentlemen in the neighbourhood, with the physicians and surgeons of this place, to erect a Public Hall at their own private charges, to use all means for improvement of the Natural History, to make a collection of curiosities, wherever they have come a good length, and to establish a Physik Garden, whereof I am overseer."

In 1712 Blair was made an M.D. of Aberdeen. In 1713 he toured the South of England and visited London, to which he returned under less fortunate auspices after the Jacobite rising of 1715. His connexion with the Jacobite sympathisers in Dundee led to his imprisonment in Newgate and to sentence

of death. The influence of his friends, Sloane and Pettiner, secured his pardon and release. He remained in the South after this, first in London and then in Boston (Lincolnshire), where he died in 1728. His principal works are as follows :—

1713—" Osteographia Elephantina " (reprint of R.S. paper).
1718—" Miscellaneous Observations in Physic, Anatomy, Surgery, and Botanicks."
1720—" Botanic Essays," including a discussion on sex in plants, structure of plants, classification, nourishment, and circulation of the sap.
1723-1728—" Pharmaco-Botanologia ; or an Alphabetical and Classical Dissertation on all the *British* Indigenous and Garden Plants of the New London Dispensatory."

George Don, 1764-1814.

According to Knox (Scottish Naturalist, 1883-4), George Don was born in the parish of Menmuir, Forfarshire, in 1764, to Alexander Don and Isobel Fairweather. He was educated at Forfar, and on leaving school apparently spent a brief period with his cousin, gardener at Dupplin. Later he became a clockmaker. The record of his earlier years and wanderings is obscure, and has been pieced together from dates of herbarium specimens. He states himself that he " first began his botanical excursions in the Highlands in 1779." Between 1784 and 1790 he visited Worcestershire, Doncaster, Bristol, Surrey, Essex, London, Oxford. About 1789 he married Caroline Clementina Oliphant Stewart, and about the same time began work as a journeyman in Glasgow, from which centre he continued his botanical excursions. In 1794 he visited Skye, and in 1795 he worked the Clova Hills. In 1797 he purchased the ground called the Dovehillock, near Forfar. Here he built a house and grew vegetables for market, but also constructed a botanical collection, systematically arranged, of native plants. In 1801 and 1802 he explored Lochnagar and the Cairngorms, and in 1802 he was appointed (at a salary of £40) to be the principal gardener of the Royal Botanic Garden, Edinburgh. He did not remain long in Edinburgh (1802-06) ; the meagre stipend was insufficient to keep a large family in the city, and Don loved the freedom of the countryside. Nevertheless, while there he added many plants to the local flora, and in 1803 was made an Associate of the Linnean Society.

Returning to Forfar, he continued his expeditions, but his small business gradually fell away, and he became seriously impoverished. Material conditions did not improve, and in the end of 1813 he returned from an expedition with a severe cold. A suppurating throat followed, and after lingering for six weeks he died on 15th January 1814, in such extreme poverty that he and his family were dependent upon neighbours' charity.

Towards the end of his life and for some time after his death Don's work was the subject of severe and not always unprejudiced criticism. More recent study and revaluation has led to a new appreciation of his pioneer labours. His name is perpetuated in botanical science by the following plants :— **Rosa Doniana, Salix Doniana, Agropyron Donianum, Grimmia Doniana, and Seligeria Doniana.**

A memorial to Don was erected in Forfar churchyard in 1910 by public subscription raised by the efforts of G. Claridge Druce, John Knox, and the Forfar Field Club.

Sir James Ivory, 1767-1842.

Began life as a flax spinner in Dundee, but turned his attention to mathematics, and after gaining the degree of M.A. taught in the Dundee Academy.

Later he became Mathematical Professor of Sandhurst Military College, Fellow of the Royal Societies of London and Edinburgh, Corresponding Member of the Scientific Societies of Paris and Gottingen, and a Knight of the Order of Hanover.

Robert Brown, 1773-1858.

Robert Brown was born at Montrose, the second son of the Rev. James Brown, an Episcopalian minister. He studied at Marischal College, Aberdeen, and the University of Edinburgh. While still a student he communicated a paper (critical list of additions to Lightfoot's " Flora Scotica ") to the Edinburgh Natural History Society. On leaving college he entered military service, and spent some time in Ireland and in London. During his time in London he continued his botanical studies with Sir Joseph Banks, becoming an Associate of the Linnean Society in 1798. He served again in Ireland until 1800, when he was appointed naturalist to an expedition about to be dispatched to survey the Australian coasts. He was with this expedition over four years, during which the southern portion of Tasmania and the southern, eastern, and northern shores of Australia were explored. He returned with large collections (4,200 specimens), of which Brown himself collected and described 3,900. His results and observations are contained in his *Prodromus Florae Novae Hollandiae*, of which the only volume published appeared in 1810. In the same year he became Librarian to the Linnean Society, and in 1811 a Fellow of the Royal Society. In 1822 Brown resigned the Librarianship of the Linnean Society and became a Fellow ; in 1823 he became a member of the Linnean Council. In 1827, in fulfilment of the wishes of their original owner, the Library and Herbarium of Banks were incorporated in the British Museum, and Brown was appointed Keeper of its botanical collections, which office he held until his death in 1858.

During this period Brown first became Vice-President (1828) and then President (1849) of the Linnean Society. He received the degree of D.C.L. of Oxford (1832), and became (1833) a Foreign Associate of the French Academy. He received the Royal Prussian Order " Pour le Merite," and a Civil List pension of £200 in recognition of his services to science. The Royal Society bestowed a Copley medal on him in 1839.

Brown's powers did not wane with old age : the work of his later period was as outstanding in quality and extent as his earlier. He joined with a natural genius an extraordinary power of application and a powerful physique which enabled him to describe his plants practically as he collected them, leaving only the finishing touches to be added in the study.

Von Humboldt's description of Brown as " botanicorum facile princeps " was accepted by his contemporaries and his successors, as witnessed by the eulogies of Von Martius (written at his death) and of Hooker some thirty years later.

Patrick Matthew, 1790-1874.

Patrick Matthew was born near Scone in 1790. Educated at Perth Academy and Edinburgh University, he inherited on his father's death the estate of Gourdiehill, near Errol. Matthew was then 17 years of age. He married his cousin, Christian Nicol, in 1817. Matthew travelled extensively on the Continent, in France, the North of Spain, Hamburg, and Holstein, where he purchased an estate. He died at Gourdiehill in 1874.

Matthew was keenly interested in politics and economics, and their relations to forestry and agriculture, of which his own life gave him practical experience. His chief claim to remembrance rests upon his work on " Naval Timber and Arboriculture," published in 1831, and containing in an appendix his views on Natural Selection, in which he anticipated Darwin and Wallace. His claim to priority was fully admitted by Darwin, and an essay by Walther May (Zoologische Annalen, Vol. IV., p. 280, 1911) shows how complete his anticipation really was.

Matthew also published in 1839 a book called " Emigration Fields," and in 1864 a political pamphlet on " Schleswig-Holstein," on whose title page he describes himself as " solver of the problem of species." In 1867 at Dundee he read a paper (not published in the " Report ") to the Economics Section of the British Association on " Capital and Labour."

In his latter years Matthew gave much attention to the question of exhaustion of the soil, holding that " high farming and the application of foreign and artificial manures are fast increasing the sterility of our land."

It is perhaps natural that Matthew, living in a time when the direct and indirect effects of war on the human struggle for existence were so evident, should have had his mind focussed upon these problems. His own experience in agriculture would bring before him the effects of natural and artificial selection upon crops and livestock. It is extremely interesting that he should have effected a synthesis of these experiences and arrived at the philosophical conclusions on evolution which he published in " Naval Timber."

Sir Charles Lyell, 1797-1875.

Charles Lyell was born at Kinnordy, near Kirriemuir, in 1797. He studied at Oxford, and his early interest in Geology was encouraged and fostered by Buckland. He became a Fellow of the Geological Society at the early age of 22, and four years later became one of its Secretaries. After leaving the University he returned home for a short period, and found much to interest him in his native county, which had so far been only superficially studied from the geological point of view. He recognised for the first time the anticlinal arch of the Sidlaw Hills and the synclinal trough of the Mearns, and the illustration of the true geological structure of Forfarshire which he gave in his " Elements of Geology " became a classic. His first published paper (1825) was on a dyke of igneous rock discovered near his home. Diggings on the site of a former lake at Kinnordy also gave him material for another paper, comparing recent fresh-water deposits with those of earlier geological periods.

For a dozen years after this period Lyell travelled widely in Europe, contributing no more to Forfarshire geology. In 1840, however, Agassiz announced his belief in the glaciation of Britain. Lyell brought forward new

evidence in support of this contention in his interpretation of two lakes in the Clova Hills. These lakes were found in rocky corries, penned up by mounds of earth and stones, which Lyell described as true glacier-moraines. This marked the beginning of the long series of writings on the Ice Age in Scotland.

All his life Lyell believed in the necessity of first-hand observation over a wide field. In pursuit of this he travelled extensively in Europe, North America, and Canada, seeing for himself the work of others on their own ground, and often by his keen observation detecting errors and noting new evidence.

To his remarkable powers of observation Lyell added a flexible and powerful literary style, which showed itself in all his writings, not least in the classic " Principles " and " Elements " of Geology, and which undoubtedly assisted in establishing the world-wide influence which he has had in placing geology on a firm basis as an observational science.

Patrick Bell, 1799-1869.

Patrick Bell was born in the parish of Auchterhouse, near Dundee, in 1799. While studying for the ministry at the University of St. Andrews he turned his attention to the construction of a mechanical reaper. A machine made to his design was tested on his brother's farm in 1827. Bell did not patent his machine, but it was in regular use until about 1868, when it was placed in the museum of the Patent Office. Although anticipated by Common, who produced in 1812 a machine having the essential principles of the modern reaper, Bell must be considered an independent inventor and one of the pioneers in the making of modern farm machinery. He reported on his invention to the British Association Meeting in Dundee in 1867.

Bell was ordained in 1843, and held the post of parish minister of Carmyllie, Arbroath, until his death in 1869.

He received the honorary LL.D. of St. Andrews.

James Bowman Lindsay, 1799-1862.

Born at Carmyllie in 1799 and apprenticed to a hand-loom weaver, his studious nature finally determined his father to send him to St. Andrews University. He had intended to proceed to the study of divinity, but in 1829 was appointed lecturer in Science and Mathematics in the Watt Institution in Dundee. Later (1841) he was appointed teacher in Dundee Prison at a salary of £50 per annum, a post which he held for 17 years, resigning in 1858 on receiving a government pension of £100 per annum " in recognition of his great learning and extraordinary attainments."

His life interests were divided between philology and electrical science. For more than 25 years he devoted his spare time to a Pentecontaglossal Dictionary, which was well advanced at the time of his death. Subsequently the manuscript was collected and placed in the Dundee Public Library. The " Pentecontaglossal Paternoster, or the Lord's Prayer in Fifty Languages " was published in 1846, and the " Chrono-Astrolabe : a full set of astronomical tables " in 1858.

Lindsay's electrical researches were carried on intermittently with his philological work, and an autobiographical note indicates that between 1832 and 1835 he was working on the problem of electrical light. He states that he

obtained " a constant stream of light " on 25th July 1835. The details of his generator are unfortunately unknown.

In 1843 he proposed a submarine telegraph across the Atlantic after having proved the possibility by a series of experiments.

In a letter to the *Dundee Advertiser* (6/5/1845) he describes an " Autograph Electric Telegraph," in which a cable of 24 wires was to be used (one for each letter of the alphabet), with an ingenious device at the receiving end whereby the magnetic deflection of any wire released a corresponding lettered pith ball, the lettered balls to be collected in sequence in a receiver, and the message read off directly. In the postscript to this letter he suggests that the return current might be sent by sea without any wires, thus proposing wireless telegraphy in theory in 1845, eight years before he demonstrated it by public experiment.

Philology claimed his attention until 1853, when he announced a lecture with experiments on telegraphic communication through water without wires. He demonstrated his method on a larger scale at Carolina Port, Dundee, over a distance of about 120 feet in salt water, and later across the Tay in fresh water. In 1854 he took out a patent for it. In August of the same year he succeeded in sending messages 500 yards across the Mill-dam at Portsmouth. His greatest performance was across the Tay between Dundee and Woodhaven, a distance of about 2 miles. His apparatus consisted (on the transmitting side) of two large immersed plates connected with wires, a galvanic battery, and a commutator for giving the signal ; on the receiving side, of two large plates, an induction coil, and the recording apparatus. He found that the strength of transmitted current depended on battery power, surface of immersed sheets, " lateral distance " of immersed sheets, and distance through the water. By suitably increasing the first three he calculated it should be possible to transmit to America. He communicated his experiments to the British Association in Aberdeen in 1859, the title of the paper being " On Telegraphing without Wires," winning the special commendation of Lord Rosse, president of the section.

He carried out further public demonstrations on the Dee and at Liverpool : the latter were not successful, but he succeeded again on the Tay in 1860. This was his last public connexion with the telegraph. In his lectures and his writing he envisaged the general use of electric lighting, power, and communication which are now a commonplace, but which then showed the power of his scientific prevision of the future.

William Gardiner, 1808-1852.

William Gardiner was born at the West Port, Dundee, in 1808. His parents were in humble circumstances, and he was apprenticed to an umbrella-maker. Entirely self-educated, he early showed a leaning towards natural history, which was encouraged by his father and later by a sympathetic employer.

In 1838 he accepted an offer from the Botanical Society of Edinburgh of five guineas for a collection to be made of 2,500 plants from the Perthshire Highlands, an undertaking which was the beginning of his career as a collector, for in 1844 he abandoned his trade and devoted himself entirely to this work. From this time on he supplied extensive and well-prepared collections of

plants to subscribers and others in the United Kingdom and abroad. He became an Associate of the Botanical Society of Edinburgh in 1838, and of the Linnean Society in 1849. In addition to smaller articles and papers, he published " Botanical Rambles in Braemar in 1844, with an Appendix on Forfarshire Botany, 1845," " Twenty Lessons on British Mosses," 1846 and 1849, which included dried specimens.

" The Flora of Forfarshire," 1849. This was Gardiner's principal work, and a curious point arises in connexion with it. A review of the book states that it is " by the author of a Flora of Ten Miles Round Dundee." No record of the publication of this book is known ; but what appears to be a prospectus of such a work exists and was commented on by Sir Joseph Hooker.

Towards the end of his life Gardiner fell into poverty, and a subscription was raised from his clients and correspondents too late to be of help to him. He died of typhus in 1852, and the money subscribed was used for the benefit of his only son.

His botanical collections were acquired by Professor Babington of Cambridge.

Patrick Geddes, 1854-1932.

Patrick Geddes was born in Perth in 1854. He was educated at Perth Academy, Royal School of Mines, University College, London ; the Sorbonne, and the Universities of Edinburgh and Montpellier. His early interest in biology, quickened and broadened by extensive travel, became merged in sociology, to which his later life was devoted. He became Professor of Botany in University College, Dundee, in 1888, a post which he held until 1920. Although his formal teaching was confined to the summer term only, nevertheless his vital spirit and personality left its imprint upon generations of students. His talent for " planning " showed itself in the original scheme for the garden at University College, where each line of path had its meaning, and where the beds were planted to illustrate an evolutionary classification as well as to ornament the grounds. No plan or written record of his scheme exists, and on his retiral it fell into disorder, and the radical alterations necessitated by the widening of the Perth Road have swept away most of Geddes' original garden, but the " Philosopher's Walk " of lime trees along the old wall is still there, and the spring beauty of azaleas and bluebells is a reminder of older times.

After his time in Dundee, Geddes became Professor of Sociology and Civics in the University of Bombay, and later Director of the Scots College, Montpellier. This last phase showed an application on an international scale of the ideas which lead to his founding the Outlook Tower in Edinburgh. Geddes' overwhelming desire was to help men to understand themselves in relation to their environment and so to adjust them as to secure betterment for future generations as well as for themselves. In a generation of analysts Geddes strove always towards a synthetic outlook. This attitude informed all his activities. He was a pioneer in regional and town planning, and became president of the Sociological Institutes of London, Edinburgh, and Montpellier.

His publications included books on Evolution and Sex, Biology (with J. Arthur Thomson) ; City Development, Cities in Evolution ; Life and Work of Sir J. C. Bose, etc.

He died at the Scots College, Montpellier, in 1932.

Sir Alfred Ewing, 1855-1935.

James Alfred Ewing was born in Dundee in 1855. He was educated at Dundee High School and the University of Edinburgh. In 1878 he went to Japan as Professor of Mechanical Engineering in the University of Tokyo. In 1883 he returned to his native town as Professor of Engineering at University College, Dundee, and after seven years' service he went to Cambridge to the chair of Mechanism and Applied Mechanics. In 1903 he was offered the post of Director of Naval Education, a post which gave full scope to his genius for administrative work. On the outbreak of war in 1914, Ewing was asked to undertake yet another arduous task, the dealing with enemy cipher. The secrets of this immensely important defence work have never been revealed, even the fact of Ewing's connexion with them was kept secret until long after the end of the war.

In 1916, while still immersed in his war work, Ewing was invited to become Principal and Vice-Chancellor of the University of Edinburgh. When he took office Ewing was 62 years of age, but his untiring zest for work and great bodily vigour enabled him to accomplish great and far-reaching developments in the University during his twelve years there. During this time he saw the establishment of 13 new chairs and numerous lectureships : the institution of the degree of Ph.D. ; the erection of new buildings for chemistry, zoology, and animal genetics, and the planning of new departments of geology and engineering. Ewing's skill in securing endowments of over three-quarter million sterling enabled these improvements to be carried through without too great a burden on the University finances.

While carrying on the burden of his administrative duties Ewing was actively engaged on some of the special committees of the Department of Scientific and Industrial Research, notably the Bridge Stress Research Committee, and he still found time for research.

Ewing was much beloved by the students of the University, and his last public appearance was when he delivered an address (" For Better or Worse ") to the Affiliated Science Societies in the same engineering classroom where his life's work began sixty years before.

During his life Ewing received many academic distinctions :—LL.D. of Edinburgh, St. Andrews, Glasgow ; D.Sc. of Oxford, Durham, Sheffield ; Sc.D. of Cambridge ; F.R.S., M.Inst.C.E. He received a Royal Medal in 1895 and an Albert Medal in 1929. He was given the freedom of the city of Edinburgh in 1929 and of Dundee in 1933.

During his last years Ewing gave much thought to the ethical bearings of science, which he stressed in his presidential address to the British Association in 1932, and developed in his Hibbert Lecture in Cambridge in 1933, and in his last book, " An Engineer's Outlook " (1933). His creed can be summed up by saying that he took as a personal injunction " *Thou* shalt love thy neighbour as thyself." His publications include :—

" Earthquake Movement," 1883.
" Magnetic Induction in Iron," 1891.
" Steam Engine and Other Heat Engines," 1926.
" Strength of Materials," 1899.
" Mechanical Production of Cold," 1908.
" Thermodynamics for Engineers," 1920.
" An Engineer's Outlook," 1933.

Sir James Walker, 1863-1935.

Born in Dundee in 1863, and educated at Dundee High School, Walker proceeded to the University of Edinburgh, where he graduated D.Sc. in 1886. He went to Leipzig where he studied under Ostwald, receiving the degree of Ph.D. in 1886 for a thesis on the "Affinity Constants of Organic Bases." After three years as assistant to Crum Brown in Edinburgh, he was appointed to the chair of chemistry in University College, Dundee, where he remained until 1908, when he returned to Edinburgh. During his tenure of this chair he saw the erection of the new Department of Chemistry at King's Buildings, completed in 1924. He erected and equipped a most efficient factory for the production of T.N.T. during the war.

He received the Makdougall-Brisbane Medal in 1895, became a Fellow of the Royal Society in 1900, was knighted in 1921, and in the same year became president of the Chemical Society. He received the Davy Medal in 1926, and the Gunning Victoria Jubilee Prize in 1933. He was an LL.D. of the Universities of St. Andrews and Edinburgh. Member of the Universities Grants Committee from 1928-1933.

Although his main interest lay in the field of physical chemistry (his text-book, "Introduction to Physical Chemistry," has passed through ten editions), Walker was also a skilled organic chemist, and his skill in attacking purely technical problems was exceptional.

He was a fine and beloved teacher; his lucidity of exposition created an effect of ease and simplicity in the most difficult subject. As friend, colleague, and teacher, James Walker will not soon be forgotten by those who had the good fortune to work in his department.

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